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WAG 9

FINAL WORK PLAN

for OPERABLE UNIT 9-04: COMPREHENSIVE RI/FS

Volume II

Prepared By
Argonne National Laboratory-West

WAG 9

APPENDIX D

ARGONNE NATIONAL LABORATORY-WEST GROUNDWATER MONITORING PLAN

for OPERABLE UNIT 9-04: COMPREHENSIVE RI/FS FINAL WORK PLAN

ARGONNE NATIONAL LABORATORY • UNIVERSITY OF CHICAGO •

WEST

Prepared By
Argonne National Laboratory-West

GROUNDWATER MONITORING PLAN

FOR

WASTE AREA GROUP - 9

ARGONNE NATIONAL LABORATORY - WEST

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1.0 INTRODUCTION

This document presents a Groundwater Monitoring Plan (Plan) for the Argonne National Laboratory - West (ANL-W) Waste Area Group - 9 (WAG-9) found within the boundaries of the Idaho National Engineering Laboratory (INEL). ANL-W is operated by the University of Chicago for the U.S. Department of Energy (DOE). The Plan has been developed consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Federal Facility Agreement/ Consent Order (FFA/CO).

1.1 Purpose and Scope

The purpose of this document is to provide a summary of historical facility operations, proposed groundwater monitoring parameters, and a plan for future groundwater monitoring at WAG-9. Specifically, the Plan will be used to address the following issues:

- Identify potential sources of groundwater contamination and maintain surveillance of those sources.
- Present data collected to detect baseline conditions of groundwater quality beneath and close to ANL-W.
- Provide a plan to permit the early detection of chemicals and radionuclides within the groundwater.
- Provide a reporting mechanism for the detection of chemicals above historical levels within the groundwater.

Each of the above issues is addressed in this Plan as it pertains to WAG-9. Applicable federal and state guidelines for groundwater monitoring are summarized in Sections 1.3. Descriptions of site FFA/CO units and operational history are presented in Section 2, and information regarding the regional geohydrological is presented in Section 3. Information on the local physical conditions at the site is given in Section 4. The recommended groundwater monitoring strategy, including information on the proposed monitoring well network, indicator parameters, and sample collection is given in Section 5. Information on statistical data analysis is presented in Section 6. Actions for the detection and response to contamination are discussed in Section 7. Procedures for data management and reporting are given in Section 8.

1.2 Background Information

The INEL was established as the National Reactor Testing Station in 1949. The INEL's prime mission is the construction and testing of various types of nuclear reactors for commercial and defense purposes. The location of the INEL Site is shown in Figure 1-1. The site encompasses an area of approximately 890 square miles in southeastern Idaho, about 29 miles west of Idaho Falls.

Argonne National Laboratory has conducted operations at the INEL since the inception as the NRTS, where it originally built and operated Experimental Breeder Reactor-I (EBR-I) (now under control of the INEL prime contractor). ANL-W is one of several major facilities found within the boundaries of the INEL. ANL-W has administrative control over an area of approximately 810 acres in the southeastern corner of the INEL. Construction began at the present ANL-W site in the mid 1950's, with the facility becoming operational in stages from 1959 through the mid 1960's. The ANL-W facility was constructed for the research and development of advanced reactor technology. Current missions are dedicated mainly to energy research and development and waste management technologies. Overall, these activities consist of irradiating reactor fuels and structural materials, and conducting high-temperature nuclear experiments, reactor physics experiments, diagnostic inspections, and laboratory analyses. Plant activities require the use and handling of various chemicals and radioactive materials, resulting in the generation of a variety of hazardous, mixed, and radioactive wastes. A map showing the locations of major ANL-W facilities and FFA/CO sites is presented in Figure 1-2.

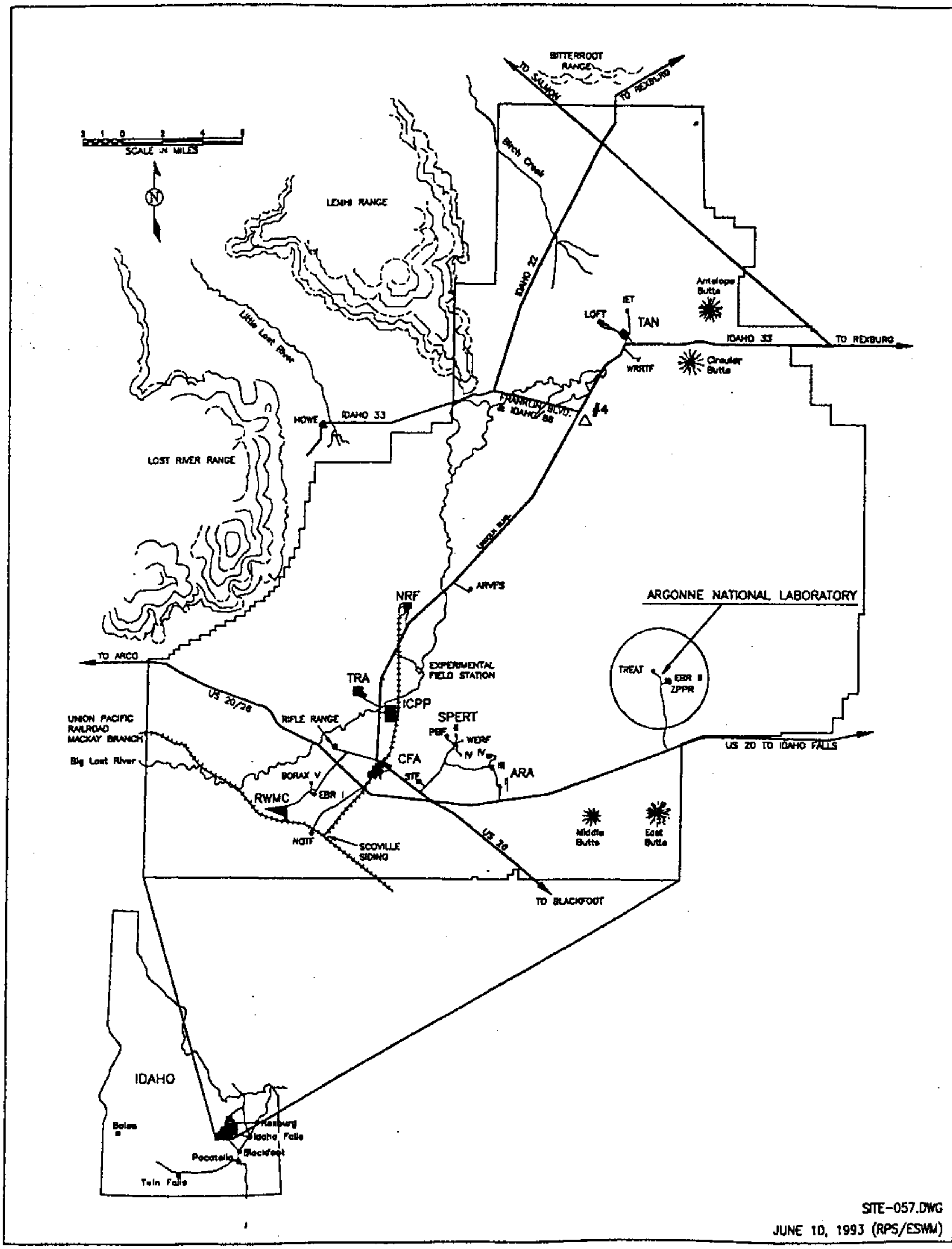
1.3 Regulatory Requirements

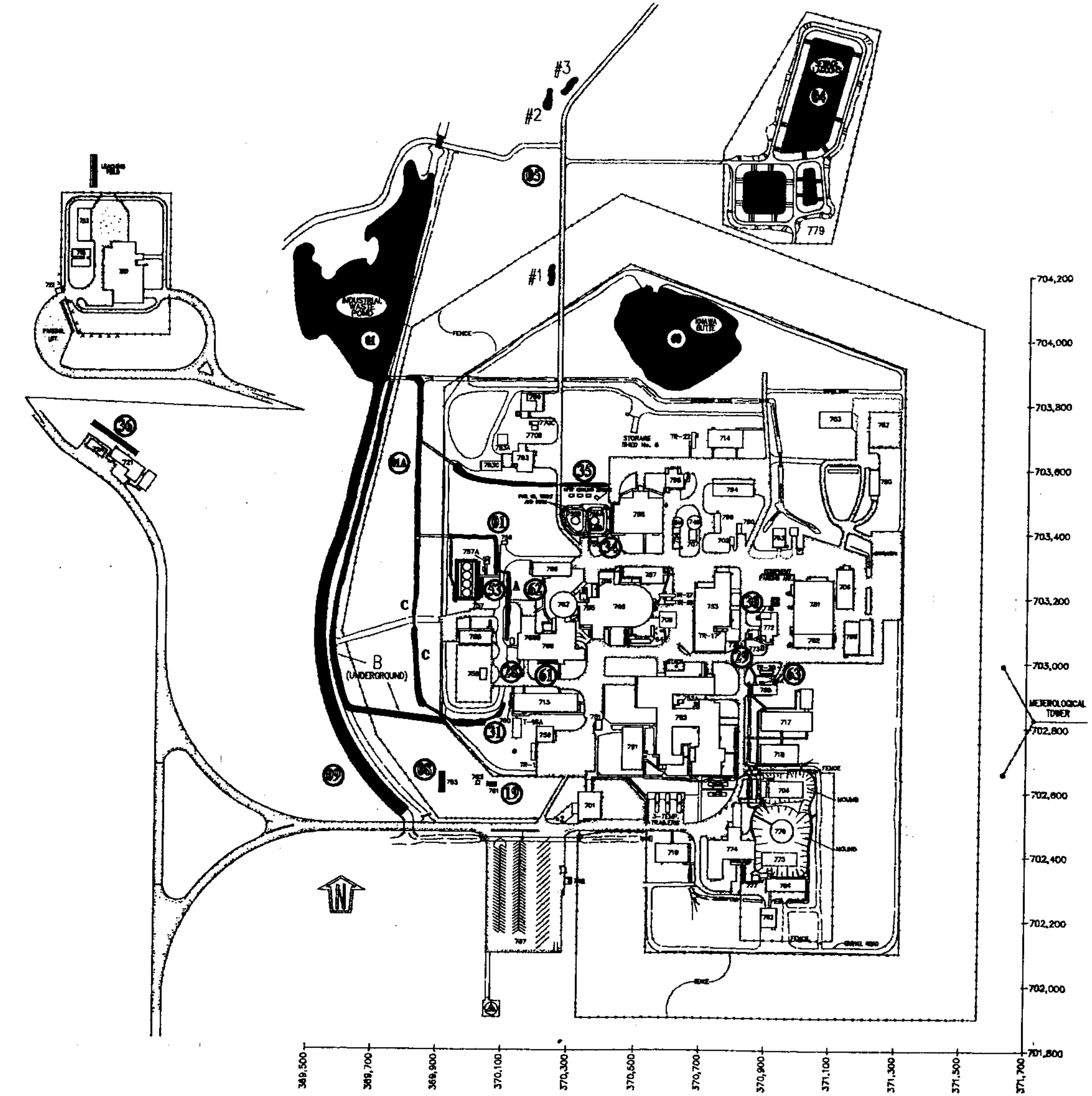
The Plan must comply with the following DOE, EPA, and State of Idaho regulations and requirements:

- INEL Federal Facilities Agreement/Consent Order (FFA/CO).
- Idaho Department of Health and Welfare (IDHW) Rules Governing Wastewater Treatment Requirements, Title 1, Chapter 2.
- DOE Order, "General Environmental Protection Program," other supporting DOE Orders and internal Department policies.
- Applicable requirements of the ANL-W Quality Assurance Program, DOE-ID Order 5700.6C, and the FFA/CO.

The FFA/CO Action Plan says that environmental investigations at the INEL will be done under the process described in the CERCLA. Overall, applicable DOE and ANL-W management and Quality Assurance (QA) requirements that are not superseded by the FFA/CO

Figure 1-1. Location of the INEL and ANL-W.





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701 SECURITY BUILDING
702 PLANT SERVICES EQUIPMENT STORAGE BLDG.
703 SODIUM STORAGE BUILDING
704 FUEL MANUFACTURING FACILITY (FMF)
706 CONSTRUCTION SHOP/STORAGE BLDG.
707 FIRE PUMP HOUSE
709 FCF SAFETY EQUIPMENT BLDG.
710 ENGINEERING OFFICE BUILDING
713 MODULAR OFFICE BLDG. T-13
714 MODULAR OFFICE BLDG. T-12
716 DOE MODULAR OFFICE BLDG. T-16A
717 MODULAR OFFICE BLDG. T-2
718 MODULAR OFFICE BLDG. T-3
719 S.I. POST T-4
742 GASOLINE/DIESEL DISPENSARY
751 REENTRY BUILDING
752 LABORATORY AND OFFICE BLDG.
752A DIESEL GENERATOR BUILDING
753 PLANT SERVICES BUILDING
754 WELL PUMP HOUSE No. 1
755 FUEL OIL PUMP HOUSE
756 WELL PUMP HOUSE No. 2
757 COOLING TOWER
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758 ELECTRICAL SUBSTATION
759 FIRE HOUSE (EBR-II)
760 SANITARY WASTE PUMP HOUSE
764A STACK MONITORING
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765A FCF OFFICE BUILDING
766 SODIUM BOILER PLANT
767 REACTOR PLANT
768 POWER PLANT
768A POWER PLANT CHANGE ROOM
768B WATER CHEMISTRY LABORATORY
769 DANGEROUS MATERIALS STORAGE BLDG.
770B SODIUM COMPONENTS STORAGE BLDG.
770C NUCLEAR CALIBRATION LABORATORY
772 EBR-II ENGINEERING LABORATORY
778 SANITARY WASTE LIFT STATION
778A INDUSTRIAL WASTE LIFT STATION
780 LAUNDRY SORTING BUILDING
781 MATERIALS HANDLING BUILDING
782 MACHINE SHOP FACILITY
783 RIGGING TEST FACILITY
785 HOT FUEL EXAMINATION FACILITY (HFEF)
786 HFEF 480V SUBSTATION
787 FUEL ASSEMBLY AND STORAGE BLDG.
788 EBR-II MAINTENANCE SHOP
789 EBR-II ENGINEERING LABORATORY
789A EQUIPMENT BUILDING
790 INTERIM CONTAMINATED EQUIPMENT STORAGE
791 INSTRUMENT AND MAINTENANCE FACILITY
793 SODIUM COMPONENTS MAINTENANCE SHOP
793C SCMS CONTAMINATED STORAGE BLDG.
794 CONTAMINATED EQUIPMENT STORAGE FACILITY
795 EBR-II COVER GAS CLEANUP SYSTEM BLDG.
796 METAL STOCK CONTROL BLDG.
798 RADIOACTIVE LIQUID WASTE TREATMENT FACILITY
799 SODIUM PROCESSING FACILITY
XENON TAG SAMPLING SHELTER
FLAMMABLE MATERIALS STORAGE BUILDING
EXPERIMENTAL EQUIPMENT BUILDING
PLANT SERVICES STORAGE BUILDING

TRANSIENT REACTOR TEST FACILITY TREAT REACTOR

715 MODULAR OFFICE BLDG. T-15
720 TREAT REACTOR BUILDING
721 TREAT OFFICE BUILDING
722 TREAT GUARD STATION
723 TREAT WAREHOUSE
724 TREAT CONTROL BUILDING

ZERO POWER PHYSICS REACTOR (ZPPR)

774 ZPPR SUPPORT WING
775 ZPPR VAULT-WORKROOM-EQUIPMENT ROOM
776 ZPPR REACTOR CELL
777 ZPPR EQUIPMENT BUILDING
784 ZPPR MATERIALS CONTROL BUILDING
792 ZPPR MOCK-UP BUILDING

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TR-17 ELECTRICAL EQUIPMENT STORAGE
TR-20 EBR-II ENGINEERING LABORATORY
TR-22 ESWM OFFICE TRAILER
TR-27 FCF CONSTRUCTION OFFICE
TR-28 FCF CONSTRUCTION OFFICE
TR-29 FCF MODIFICATION OFFICES
TR-30 TRAINING & PROCEDURES
TR-31 OFFICE TRAILER
TR-39 TEMPORARY OFFICE TRAILER
TR-40 TEMPORARY OFFICE TRAILER
TR-41 TEMPORARY OFFICE TRAILER
TR-46 RSWF OFFICE TRAILER

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ARGONNE NATIONAL LABORATORY-WEST SITE PLOT PLAN

OPERABLE UNITS 9-01, 9-02, 9-03, AND 9-04 OF WAG-9

OCTOBER 5, 1995/ESA\
087.DWG (SITE 2)

will apply to all monitoring activities. The FFA/CO does not specifically require any groundwater monitoring actions

2.0 FFA/CO SITES AND OPERATIONAL HISTORIES

In the Federal Facility Agreement and Consent Order (FFA/CO 1991), WAG 9 is divided into four Operable Units (OUs). These OUs are further divided into release sites, which are identified by site code in the FFA/CO (Figure 1-2). The four OUs contain a total of 19 sites. Each Operable Unit is discussed in detail in the following sections.

2.1 OU 9-01

This OU consists of the following 10 miscellaneous sites.

2.2.1 Sanitary Sewage Lagoons (ANL-04)

The sanitary sewage lagoons are found north of the ANL-W facility. Two lagoons were constructed in 1965 and a third was built later, in 1974. According to engineering drawings, the three sanitary sewage lagoons cover approximately two acres. The approximate dimensions of the lagoons are: (Primary)—46 × 46 × 2.1 m (150 × 150 × 7 ft), (Overflow)—15 × 30 × 2.1 m (50 × 100 × 7 ft), and (Secondary)—38 × 122 × 2.1 m (125 × 400 × 7 ft). The lagoons receive all sanitary wastes originating at ANL-W, except that from the Transient Reactor Test Facility and the Sodium Components Maintenance Shop. Sanitary wastes from these facilities are discharged to dedicated septic systems. Sanitary waste discharged is from rest rooms, change facilities, drinking fountains, and the Cafeteria. The three lagoons are sealed with a 0.32–0.63 cm (0.125–0.25 in.) bottom bentonite liner. The secondary lagoon also has a 30-ml hypalon liner on the sides.

A large leak in the northeast corner of the secondary lagoon was detected after its construction in 1974. This leak resulted in the loss of more than a million gallons of waste water through fissures that were not completely sealed by the bentonite. This was rectified by using a 30-ml hypalon liner over the northeast corner and sealing the seams. A study in 1992 confirmed that the Sanitary Lagoons are functioning as evaporative ponds and not as percolating ponds, suggesting that the bentonite and hypalon liner has remained intact (EG&G, 1992). Between 1975 and 1981, photo processing solutions were discharged from the Fuel Assembly and Storage Building to the Sanitary Waste Lift Station, which discharges to the lagoons. Photo processing ceased at the Fuel Assembly and Storage Building in 1981. Since then, no further release to the lift station, or the sewage lagoons has occurred. Excepting an occasional point source of low level medical radionuclides, no known radioactive hazardous substances have been released into the Sewage Lagoons. Periodic sampling of the Sewage Lagoon and a radionuclide detector placed in the lift station (Sanitary Waste Lift Station-788) supplying the Sewage Lagoons, support these conclusions. Because no prior sludge samples were analyzed for metals and radionuclides, seven sludge samples were collected in 1994. The results from this sampling show that the maximum concentrations of arsenic and chromium (assuming it is all hexavalent chromium) exceed risk-based soil concentrations.

Up to 1995, water from the two sanitary lagoons in operation at ANL-W (the primary and secondary) were sampled monthly, during the ice-free months April through October. The samples collected are analyzed for the following:

(i) Primary Sanitary Lagoon - alpha, beta, and gamma contamination, tritium and cadmium content and pH.
(ii) Secondary Sanitary Lagoon - Biological Oxygen Demand (BOD), Dissolved Oxygen (DO), Total Suspended Solids (TSS), and pH.

The results from the secondary lagoon samples are compared with the results obtained from identical samples taken in the sewage lift station to evaluate the efficiency of the sewage lagoon's operation.

Biannual water samples were also collected in the secondary lagoon and analyzed for low-level gamma emitters and plutonium content.

Starting in 1995 water samples were collected from a dock in the secondary lagoon for alpha, beta, and gamma contamination, tritium, sodium, sulfide, chloride, BOD, TSS, and pH. Field parameters measured are temperature, pH, dissolved oxygen, specific conductance, and turbidity. The sanitary lift station is still monitored for BOD, TSS, and the same field parameters as the sanitary pond. Procedures for sanitary lagoon and lift station sample collection and handling can be found in the ESWM Procedures Manual.

2.1.2 Sludge Pit W of T-7 (Imhoff Tank) (ANL-19)

The Imhoff Tank and sludge pit collected sanitary waste from the power plant (Bldg. 768), the Fuel Conditioning Facility (Bldg. 765), the Laboratory and Office building (Bldg. 752), and the Fire House (Bldg. 759). The Imhoff Tank was used to settle out the sanitary wastes from 1963 to 1966. After settling, the sludge from the Imhoff Tank was pumped to the adjacent sludge pit. Liquid effluent from the Imhoff Tank was discharged to the EBR-II Leach Pit (ANL-08), approximately 61 m (200 ft) to the west. The Imhoff Tank was approximately $3.7 \times 7.3 \times 5.5$ m ($13 \times 24 \times 18$ ft). The sludge pit was a 0.9 m (3 ft) diameter by 3.7 m (13 ft) tall, vertical cylinder placed 1.5 m (5 ft) south of the Imhoff Tank. Engineering drawings show that all industrial wastes and laboratory chemicals were discharged separately through industrial waste lines that bypassed the Imhoff Tank/sludge pit. It is unlikely that hazardous constituents were disposed in the Imhoff Tank and sludge pit. The Imhoff Tank and sludge pit were cut down to 0.3 m (1 ft) below grade and filled with dirt in 1978.

2.1.3 EBR-II Sump (ANL-28)

The EBR-II Sump is a 2,500 L (660 gal) underground, coated, carbon steel tank, 1.5 m (5 ft) in diameter by 1.4 m (4.5 ft) in depth located just southwest of the Power Plant (Bldg. 768). The Sump is believed to have been installed in the early 1970s and is currently in use. The tank is a centralized collection facility for cooling tower blowdown, ion exchange regeneration effluent, and small quantities of laboratory chemicals, from the water chemistry laboratory in the Power Plant, before discharging via a pipe to the Main Cooling Tower Blowdown Ditch. Because of budget cuts, the Power Plant has not operated since October of 1994. The main cooling tower basin has also been drained.

The sump was originally used to raise the pH of low-pH water derived from the cooling tower blowdown wastewater. Before 1980, hexavalent chromium was used as a corrosion inhibitor and therefore, low levels of chromates were discharged through the sump, although this hexavalent chromium was chemically modified to trivalent chromium, thus resulting in low-pH waste water. The pH of waters discharging through the sump is typically between 6 and 9, but it can vary between 4 and 11. A neutralization tank was installed inside the Power Plant in 1985 to ensure that the pH of discharged waters stays between 4 and 11.

Since 1980, a phosphate-based corrosion inhibitor was used instead of hexavalent chromium. Chromates have not been discharged through this sump since July 1980. The caustic injection system and pumps have since been removed from the sump, and wastewater currently flows directly through the sump to an underground pipe that discharges at the Main Cooling Tower Blowdown Ditch. Total discharges through the sump are estimated at 438 million gallons over the past 23 years. No sludges or sediments remain at the bottom of the tank.

2.1.4 Industrial Waste Lift Station (ANL-29)

The Industrial Waste Lift Station was installed on the east side of the ANL-W site in 1972. It receives the industrial waste effluents from the Zero Power Physics Reactor support wing (Bldg. 774), the Lab and Office Building (Bldg. 752), the EBR-II Engineering Laboratories (Bldgs. 772 and 789), and the Fuel Manufacturing Facility (Bldg. 704). The waste effluents from these facilities are then discharged, from the lift station, to the Industrial Waste Lift Station Discharge Ditch (ANL-35), also known as the North Ditch, which is north of the Hot Fuel Examination Facility. The only contaminant of potential concern identified from process knowledge of water released to the Industrial Waste Lift Station is silver. Sludge samples collected in 1986 from the Industrial Waste Lift Station detected silver at 23,700 mg/kg. Silver recovery units were installed on photo processing units at ANL-W in September 1986 and solutions containing silver were not allowed to be directly discharged into the industrial waste systems. However, on October 3, 1990, photo processing solution was inadvertently discharged directly into the Industrial Waste Lift Station, bypassing the silver recovery units installed at the EBR-II Engineering Laboratory (Bldg. 772). Sludge samples collected in 1990 show 28 mg/kg of total silver. In 1990, the silver recovery units throughout ANL-W were modified and operating procedures were updated to prevent any further silver releases. Additional sludge samples were collected from the bottom of the lift station in 1995 and analyzed for total silver, TCLP silver, and gamma spectrometry. Results of the gamma spectrometry show that Cs-137 was detected at a maximum concentration of 8.7 pCi/g. However, this sludge is 4.6 m (15 ft) below land surface (BLS) and the only complete exposure pathway is groundwater of which this value is less than the risk-based concentration. The maximum detected soil concentration of silver is 5,400 mg/kg and this concentration does not result in a potential health risk greater than the lower limit of the NCP target risk range.

2.1.5 Sanitary Waste Lift Station (ANL-30)

The Sanitary Waste Lift Station (Bldg. 778) was built in 1965. It receives all sanitary waste originating at ANL-W, except for the Transient Reactor Test Facilities (Bldg. no.s 720, 721, 722, 724, and T-15) and the Sodium Components Maintenance Shop (Bldg. 793). These two facilities discharge to dedicated sanitary septic systems. The Sanitary Waste Lift Station, which consists of a sump approximately 1.8 m (6 ft) in diameter and 4.9 (16 ft) deep, discharges to the Sanitary Sewage Lagoons (ANL-04). Between 1975 and 1981, photo processing solutions were discharged from the Fuel Assembly and Storage Building to the Sanitary Waste Lift Station. The manager of Fuel Assembly and Storage Building during that period, estimates that approximately 1.32 Troy ounces of silver were discharged to the Sanitary Waste Lift Station. Photo processing was stopped at the Fuel Assembly and Storage Building in 1981 and consequently, there have been no further releases to the Sanitary Waste Lift Station.

2.1.6 TREAT Photo Processing Discharge Ditch (ANL-36)

The Transient Reactor Test (TREAT) Photo Processing Discharge Ditch is found approximately 6.1 m (20 ft) northeast of and parallel to the Photo Lab (Bldg. 724) and the TREAT Office Building (Bldg. 721). The ditch is a very shallow [i.e., 15 cm (6 in.)] linear depression approximately 165 m (540 ft) long by approximately 1.8 m (6 ft) wide. Approximately 1,500 L (400 gal) of photo processing solutions are estimated to have been discharged to the ditch over the two-year period from 1977–1979. It is unlikely that the photo processing solutions actually had an impact on the entire length of the ditch. This is because of the small volume of solutions discharged to the ditch at any one time, and the short length of time it was used. Wastes discharged to the ditch were generated in the Photo Lab. In 1987, twenty soil samples were collected from the ditch and qualitatively screened by x-ray spectrometry. Of these twenty soil samples, three were analyzed for total silver.

2.1.7 Knawa Butte (ANL-60)

The Knawa Butte is found due north of the Hot Fuel Examination Facility (Bldg. 785) near the security fence. As ANL-W began to expand, previously undisturbed areas within the security perimeter became the site for new facilities. Miscellaneous construction debris, including refuse concrete, and rocks and dirt from the excavation of the Hot Fuel Examination Facility and the Experimental Breeder Reactor-II (Bldg. 767) basements were disposed at Knawa Butte. The butte was used as a construction refuse pile until September 1972 when a service request was made to renovate the existing pile and convert it to a doughnut-shaped mound.

The butte continued to be used as a disposal area until October 1975, when it was decided, because of tightened security control, that construction refuse should be disposed of elsewhere. ANL-W personnel concluded that future excavation material (i.e., rock and dirt) would be dumped into a manmade depression, which developed during construction of the Zero Power Physics Reactor mound, found approximately 457 m (1,500 ft) south of ANL-W. The butte was then covered with clean soil and planted with grasses to aid the ecological recovery of the area. During May of 1986, a security bunker was installed in the northernmost section of the butte. The bunker is used to store ammunition and continues to be used by ANL-W Security today. In September of 1992, several, three feet deep holes were dug in the Knawa Butte that verified that its contents were indeed excavation and construction debris.

2.1.8 EBR-II Transformer Yard (ANL-61)

The EBR-II Transformer Yard found south of the EBR-II Power Plant (Bldg. 768) is the site of PCB and diesel fuel contamination. The PCB contamination is due to historic (i.e., before 1978) leakage from four transformers. All four transformers were replaced and most of the contaminated soil was removed during a cleanup action from 1988 through 1992. Approximately 54 m^3 (70 yd^3) of PCB-contaminated soil was removed and transported to an offsite disposal facility. The concrete pads supporting the transformers were solvent cleaned, etched, and coated with an epoxy resin as a temporary mitigation measure. Additional soil sampling was done in 1991 and an additional 386 m^3 (505 yd^3) of PCB-contaminated soil and concrete was removed in 1992. One hundred and sixty-six verification soil samples were collected in 1992. Three of these verification soil samples had PCB concentrations greater than the Toxic Substances Control Act Action Limit of 25 mg/kg. These soil samples were collected directly below Transformer #3 and directly above the basalt at approximately 2.3–2.4 m (7.5–8.0 ft) below land surface. At these locations, the soil was removed to bedrock and a bentonite barrier was placed directly above the basalt. The area was then backfilled with clean soil and new transformers installed. Thirty-eight additional verification soil samples were collected in a ditch south of the transformer yard. Two of the soil samples had PCB concentrations greater than the 25 mg/kg action limit. Therefore, fourteen verification soil samples were collected in this area. Two soil samples had PCB concentrations above the action limit. The soil was removed and 12 additional verification samples were collected. Those 12 soil samples had PCB concentrations below the action limit. Six soil samples were collected east of the transformer yard. Two soil samples near an underground storage tank had PCB concentrations of 55 mg/kg and 39 mg/kg. This soil will be excavated when the tank is removed in 1998. However, because this soil has not been removed, it is identified as a new site (ANL-61A).

2.1.9 Sodium Boiler Building Hotwell (ANL-62)

The Sodium Boiler Building (Bldg. 766) condensate hotwell, built in 1962, is north of the EBR-II Power Plant (Bldg. 768). This hotwell, which is identical to the EBR-II Power Plant condensate hotwell (Bldg. 768), receives water from the steam trap and condensate drains. Water contained in the Sodium Boiler Building Hotwell sump is pumped back into the system instead of being discharged to the environment.

The boiler feedwater treatment program, from initial startup to September 1986, used a 35% solution of hydrazine as an oxygen scavenger and morpholine as a neutralizing amine. In September 1986 the treatment program was modified and now uses a carbohydrazide as an oxygen scavenger and a blended neutralizing amine (dimethylisopropanolamine and aminomethylpropanol). Tritium, produced in the EBR-II Reactor, migrates through the evaporator and superheater tube walls to the steam system. The level of the tritium in the condensate averages about 10^{-5} μCi/mL, which is below the DOE Order 5480.11 limits on effluent discharge of radionuclides to the environment of 3×10^{-3} μCi/mL. To verify there has been no migration of the tritium from the condensate to the groundwater tritium analyses were performed monthly on groundwater from the two production wells at ANL-W. In November 1995 analysis was reduced to a quarterly basis. Tritium has not been detected above the 2×10^{-7} pCi/mL detection range.

The total discharge of hydrazine from the Sodium Boiler Building hotwell is less than 4 mg/year during normal operation. Although trace quantities of hydrazine are present in the condensate, these minute amounts will scavenge oxygen in the hotwell or the industrial waste feeder ditch and be consumed.

2.1.10 Septic Tank 789-A (ANL-63)

This septic tank is found approximately 18 m (60 ft) northeast of the Equipment Building (Bldg. 789-A) and was believed to have been installed in the late 1950s. No buildings currently discharge to the septic tank and it was not shown on any ANL-W engineering drawings. An employee who worked at ANL-W in 1961 reported that construction trailers near the septic tank were being dismantled and moved then. The septic tank was not in use and the outer ANL-W fence was approximately 33 m (100 ft) to the west of the tank/trailers. Therefore, it is assumed that the septic tank only received sanitary waste effluent from the temporary construction trailers before the beginning of operations at ANL-W. The tank was inadvertently discovered in 1986 when a fire hydrant in the vicinity was being replaced. It is reported that there was fluid in the tank and a sample was collected for radioactive analysis. The analytical results are reported to have shown no radioactive contamination, although the actual laboratory results cannot be found. The tank was removed in 1988.

2.2 OU 9-02

OU 9-02 consists of one site, the EBR-II Leach Pit (ANL-08). The EBR-II Leach Pit is between the inner and outer security fences in the southwest corner of the ANL-W facility. The pit is an irregularly shaped, unlined underground basin approximately 5.5 m (18 ft) wide by 12 m (40 ft) long; the bottom of the Leach Pit is 4.6 m (15 ft) below land surface. The Leach Pit was excavated into basalt bedrock in 1959 with explosives. A 20 cm (8 in.) thick, reinforced-concrete slab lid was installed 1.5 m (5 ft) below land surface and covered with native soil to prevent the ingress of wildlife and precipitation. In 1991, as part of a Track 2 investigation, soil samples were collected from the leach pit, the interbeds below the leach pit, and surface locations in the leach pit. Also a groundwater sample was collected from a well (ANL-MON-A-11) drilled down gradient from the leach pit. Groundwater and soil samples were analyzed for VOCs, semivolatile organic compounds, metals, radionuclides, anions, and pH. The results suggest the sludge samples in the leach pit and the soil samples collected below the leach pit in the interbeds had contamination. Results from the Track 2 type risk assessment show that cadmium concentrations exceed the TCLP limit and are considered hazardous waste. A Track 2 type risk assessment was done which suggested that OCDD detected in the groundwater presents a potential risk of 1×10^{-6}, or at the lower limit of the NCP target risk range. Groundwater concentrations of radionuclides exceed the risk-based levels but soil concentrations of metals are below levels that suggest potential adverse health effects. Cs-137, Co-60, Sr-90, and I-129 soil concentrations exceed threshold concentrations established for decontamination and decommissioning of INEL sites (EG&G 1986), but below the lower limit of the NCP target risk range. Based on the results of this investigation the overburden and lid were removed in the fall of 1993 as part of a removal action conducted under the CERCLA, as amended. Most of the sludge was removed in December 1993, the bottom of the Leach Pit was lined with 5 to 7 cm (2–3 in.) of bentonite clay and backfilled to grade. Samples were collected from the basalt. A risk evaluation done on the concentration of the COPCs in the basalt and in the remaining sludge suggests that the total potential adverse health effects are 6×10^{-6}. This is at the lower limit of the NCP target risk range of 1×10^{-6}.

2.3 OU 9-03

Operable Unit 9-03 consists of three miscellaneous sites.

2.3.1 ANL Open Burn Pits #1, #2, and #3 (ANL-05)

Three abandoned open burn pits are found at ANL-W. Two of the pits (#2 and #3) are side by side approximately 91 m (300 ft) north of the north security fence and pit #1 is found between the north security fences. The pits were initially used to burn construction wastes, such as paper and wood as early as 1960. In addition, approximately 150 gals of organic wastes from analytical chemistry operations were disposed in the burn pits from 1965-1970. The exact locations of where the organic compounds were dumped are not known. These organic laboratory wastes were collected in a 5-gal glass carboy emptied into the pits just before scheduled burns. After a burn the pits were covered with a layer of native soil. Interviews with employees who worked at the site at the time say that approximately 25–30 gals per year of organic laboratory wastes were disposed in the pits over a 5-year period from 1965–1970, for a total of 150 gals. The organic wastes consisted primarily of toluene, xylene, hexane, isopropyl alcohol, butyl cellosolve, tributylphosphate, and mineral oil. Mineral oil accounted for approximately 50% of the organic mixture. Random soil samples were collected from the burn pits in 1988 and 1994. A preliminary risk assessment was done which suggests that the risk from exposure to U-238 is 1×10^{-6}, or at the lower limit of the NCP target risk range.

2.3.2 Industrial/Sanitary Waste Lift Station, Building 760 (ANL-31)

The Industrial/Sanitary Waste Lift Station (Bldg. 760) is actively used on the sanitary side. However, the industrial side is inactive. Both the industrial and sanitary sides of the waste lift station are approximately 1.8 × 1.8 × 4.2 m (6 × 6 × 14 ft) reinforced concrete. No hazardous constituents have been identified as having been routed through the sanitary waste side. Acids and bases identified in the Initial Assessment for the "ANL Interceptor Canal" were discharged through the industrial waste side of the lift station. In 1995, samples were collected from the water and sludge and were analyzed for metals and radionuclides. Results from a Track 2 risk assessment suggest that several radionuclides pose a risk at the lower limit of the NCP target risk range. Therefore, a removal action was completed to remove the source at this site (i.e., water, sludge, and piping) in November 1995.

2.3.3 Fuel Oil Spill by Building 755 (ANL-34)

ANL-34 is the site of a 50-gallon spill of #5 fuel oil from an above ground storage tank. The #5 fuel oil was heated in order for it to flow into the tank. A sight glass used as a control mechanism failed during a filling operation. At the time of the spill, the tank was surrounded by a large earthen berm approximately 1.2 m (4 ft) high and 18.3 × 18.3 m (60 ft × 60 ft) square at the inside base of the berm. The spilled fuel oil occupied an area approximately 1.5 m × 6.1 m (5 ft × 20 ft) and was confined within the berm area. A risk assessment was done on the most mobile (i.e., naphthalene) and the most hazardous (i.e., benzene) constituents of fuel oil. The risk assessment shows that the risk would be below the lower limit of the NCP target risk range.

2.4 OU 9-04

OU 9-04 consists of five sites. These sites are involved with the transport of surface water runoff, cooling tower blowdown water and other liquid waste disposal ditches to the Industrial Waste Pond.

2.4.1 Industrial Waste Pond and Three Cooling Tower Blowdown Ditches (ANL-01)

The Industrial Waste Pond (IWP) is an unlined, approximately 1.2 ha (3-acre) evaporative seepage pond fed by the Main Cooling Tower Blowdown Ditch (ANL-01A), the Interceptor Canal (ANL-09) and sites drainage ditches. The pond was excavated in 1959, with a maximum water depth of about 4 m (13 ft), and is still in use today. During this time, the Main Cooling Tower Blowdown Ditches (MCTBD) have been rerouted several times. ANL-W auxiliary cooling tower blowdown ditches convey industrial wastewater from the EBR-II Power Plant and the Fire Station (Bldg. no.s 768 and 759) to the Industrial Waste Pond. The IWP was originally included with the MCTBD, as a Land Disposal Unit under the RCRA Consent Order and Compliance Agreement, based on the release of corrosive liquid wastes after November 19, 1980. However, ANL-W conducted a field demonstration with the EPA and State of Idaho representatives attending in July 1988 that showed that any potentially corrosive wastes discharged to the IWP were neutralized in the MCTBD before reaching the IWP. On that basis, the EPA removed the IWP as a Land Disposal Unit and re-designated it as a Solid Waste Management Unit. Currently, two of three active ditches (i.e., Ditches A, and C) discharge to the MCTBD, which then discharges to the IWP. Ditch B also discharged to the

IWP but has since been backfilled. Because of the physical separation of these ditches to the pond, each ditch and the IWP was screened separately. Samples have been collected from the soil, sludge, and water present in the IWP and soil samples have been collected from the ditches. A Track 2 risk assessment done at the site shows that it is unlikely that exposure to metals and radionuclides will cause adverse health effects. However, the risk assessment only evaluated the soil ingestion exposure pathway, which typically the presents the greatest exposure pathway.

Before wastewater is allowed to be discharged to the IWP, its disposal must meet the requirements found in Volume 1, Section 2.3, Part 2 of the ANL-W Environment, Safety, and Health Manual (ANL-W ESH Manual). The following represent average makeups of the wastewater discharged to the IWP.

2.4.1.1. Main and Auxiliary Cooling Towers

The following discussion is on chemicals used in the main and auxiliary cooling towers.

I. Dianodic-II Treatment: The cooling water is being continuously saturated with dissolved oxygen while passing over the cooling tower. To prevent oxygen corrosion of the cooling-water system, and to control deposition, a water treatment called "Dianodic-II" is added to the system. The corrosion inhibitors in this treatment are orthophosphate (monomolecular PO_4^{-3}) and polyphosphate (a polymer containing many phosphate groups). The treatment does not use chromates for corrosion control.

"Betz 20K," the solution containing ortho- and polyphosphate, is continuously injected into the system to maintain phosphate levels between 11-15 ppm (15-20 ppm for the auxiliary cooling tower). At such high concentrations, precipitation of calcium phosphate becomes a real problem. Prevention of $Ca_3(PO_4)_2$ precipitation is accomplished by injection of another chemical called "Betz 2020." This solution contains a modified poly-acrylic acid that disperses calcium salts as well as other salts (e.g., iron and magnesium salts). Besides phosphates, the "Betz 20K" contains two other chemicals: "HEDP," which inhibits precipitation of scale ($CaCO_3$) and prevents formation of tubercles, and (2) "tolytriazole," which inhibits corrosion of copper alloys such as admiralty metal.

II. Sulfuric Acid: The purpose of the sulfuric acid addition is to decrease the bicarbonate alkalinity of the cooling tower water, thereby reducing the potential of the water to deposit calcium carbonate scale on heat transfer surfaces. The sulfuric acid reacts with the bicarbonates in the raw water, yielding the corresponding sulfates. The cooling water pH (7.4-7.8) must be controlled to prevent scale buildups.

Concentrated (93%) sulfuric acid is received in bulk and transferred to the acid storage tank located northeast of the main cooling towers. It is transferred from the storage tank to the acid measuring tank by an eductor pipe. The measuring tank drains to the acid day tank that provides a source for the acid injection pumps.

Sulfuric acid is continuously added to the main cooling tower basin. The injection rate may be varied by either automatic or manual control of the injection pump stroke (normally automatic).

The pH monitoring system is composed of the following elements:

(1)	Water Treatment Panel C:	Sample Throttle Valve PW-192 Rotameter with Flow Alarm Switch pH Cell Assembly P7-XpHT-675A Sample Isolation Valve PW-212
(2)	Water Treatment Panel A:	pH Monitor P7-XpHN-675A pH Recorder P7-XpHR-675A Acid Pump Controller P7-XpHC-675A Indicating Lights (two: high and low pH)
(3)	Water Treatment Annunciator Panel:	Pt. 7, High pH Pt. 8, Low pH Pt. 11, Low Sample Flow Rate

III. Chlorine and Slimicide Treatment: Chlorine and slimicide are added to the condenser cooling water to kill or retard the growth of microorganisms. Microorganisms can cause biological fouling of piping systems and heat exchanger equipment. Chlorine is used with a nonoxidizing biocide (slimicide) for the most effective results. Chlorine does not reach certain parts of the system due to being aerated out of the water while going over the cooling tower. Therefore, without the use of the slimicide, areas such as the cooling tower basin become likely breeding grounds for microorganisms not reached by the chlorine.

Chlorine is supplied in "Aquabrome" pellets added through a brominator (tank). The chlorine level is maintained by adding pellets once a week, unless slimicide is added. Chlorine is added once a week to a level of 0.5 ppm, free Cl, or 2 ppm total chlorine, whichever comes first.

Slimicide is manually added to the cooling tower basin once a month.

2.4.1.2 HFEF Cooling Tower

The HFEF cooling tower is a closed system and does not have any liquid discharges to the environment. Normal operating monitoring and analysis parameters are described in the following:

1. Total Dissolved Solids = 800-1000 ppm
2. Hardness = 300-400 ppm
3. pH = 8.0 ± 0.5
4. Cooling tower water is sampled during a weekly PM. Two samples are taken, one is analyzed for gross beta, the other is taken to the auxiliary boiler room for water treatment analysis.
5. Based upon the results of the water treatment analyses, water treatment chemicals are added to the cooling tower water that undergoes continuous blowdown.

2.4.1.3 EBR-II Turbine Condensate

The following monitoring and analysis is or has been conducted on the EBR-II turbine condensate.

1. The condensate is monitored every four hours for pH. The pH is maintained at 8.8 - 9.2.
2. Residual hydrazine (N_2H_4) was suspected as a carry-over from the steam; the condensate was analyzed. Results of the analysis revealed a value equal to the base accuracy of the analysis instrument, .02 ppb hydrazine. Hydrazine is no longer used in this system.

2.4.1.4 Ion Exchanger Regeneration Effluent

The following monitoring and analysis is or has been conducted on the ion exchanger regeneration effluent from the EBR-II Power Plant. This process will be changed in mid 1996 when ANL-W converts over to a reverse osmosis water treatment system.

1. According to instructions in <u>Operating Instructions for EBR-II, Chapter 13H</u>, ion exchanger regeneration effluent is piped into the industrial waste neutralization tank. Once inside the tank, the following occurs: The pH of the effluent is measured, the pH is adjusted to within a range of 4-11, then the effluent is discharged.
2. Both the effluent and the salts from the effluent have been analyzed for heavy metals. Results of the analyses revealed values less than the base accuracy of the analysis instrument.

2.4.1.5 Auxiliary Boilers

The auxiliary boilers operate under the following monitoring and analysis parameters:

1. Sulfite = 20-40 ppm
2. Alkalinity = 200-400 ppm
3. Phosphate = 30-60 ppm
4. Conductivity (max) = 800 micromhos
5. pH = 8.0-9.0
6. Boiler water is tested at least once every 24 hours when the boilers are operating.
7. The boilers are blown down only when test results show that it is necessary.

Beyond the above, all suspect wastewater (suspect in that a possibility for contamination exists) is analyzed for the suspected constituents. If the possibility exists for the wastewater to be radioactively contaminated, the suspect wastewater is monitored for gross alpha, gross beta, tritium, gamma-emitting isotopes, and pH. If wastewater is suspected to contain other hazardous substances (e.g., heavy metals), the wastewater is sampled for the suspected hazardous substance [for example see 2.4.1.3 and 2.4.1.4 above].

Besides sampling done by the facilities, the ANL-W Environment and Waste Management (EWM) section have collected monthly samples of IWP water. Up to 1994, the samples were analyzed for alpha, beta, and gamma contamination, tritium, cadmium, chromium, hexavalent chromium, sodium, silver, zinc, phosphate, sulfate, chloride, and pH. After completion of an extensive wastewater characterization effort and review of the past 14 years of data the measured constituents were modified. Starting in 1995, the pond is monitored for alpha, beta, and gamma contamination, tritium, iron, mercury, sodium, phosphate, sulfate, chloride, fluoride, and pH. Field parameters measured are temperature, pH, specific conductance, dissolved oxygen, and turbidity. Under a proposed Waste Water Land Application Permit (January 1996) ANL-W is proposing a reduction of sampling from monthly to quarterly. EWM has also collected biannual samples from the IWP in the past, which are analyzed for low-level gamma emitters and plutonium content. Procedures for the sampling and handling of these EWM IWP samples can be found in the ESWM Procedures Manual.

2.4.2 The Main Cooling Tower Blowdown Ditch (ANL-01A)

The Main Cooling Tower Blowdown Ditch (MCTBD) runs from the Westside of the cooling tower, north between the security fence, to the Industrial Waste Pond. It is an unlined channel approximately 213 m (700 ft) in length, 0.9 to 4.6 m (3 to 15 ft) wide. From 1962 to present the ditch has been used to convey industrial wastewater from the Cooling Tower to the Industrial Waste Pond. The main sources of impurities to the Industrial Waste Pond were water treatment chemicals used to regenerate the ion exchange resin that removes minerals from cooling tower water used in the EBR-II steam system. From 1962 to July 1980, a chromate-based corrosion inhibitor was added to the Cooling Tower water. The blowdown contained significant quantities of hexavalent chromium. Discharges of ion exchange column regeneration waste have occurred from 1962 to March 1986. Regeneration of these columns is accomplished with sulfuric acid for cation columns and sodium hydroxide for anion columns.

In January 1986, a pH measurement of 1.86 was measured in the effluent discharged to the MCTBD. This classified the liquid wastes as corrosive according to 40 CFR 261.22. The site was then classified as a Land Disposal Unit under RCRA. In February 1986, pH measurements were taken at the outfall to the MCTBD at 10-minute intervals during a regeneration episode; over the 4-hour observation period, pH measurements at the outfall ranged between 1.6 and 2.0 for a total of approximately 40 minutes. A temporary neutralization system was installed in March 1986 and a permanent neutralization tank was installed by October. Since October of 1986, all liquid regeneration wastes have been treated in this tank before discharge to the pond. In 1995, 21 soil samples were collected and analyzed for pH and soil buffering capacity. These measurements show that the pH in the soil ranged from 6.9 to 8.2 with the soil buffering capacity ranging from 26 to 165. Track 2 risk assessments done at the site show that exposure to metals and radionuclides will not cause adverse health effects. However, only the soil ingestion exposure pathway was evaluated.

Under normal operating conditions when routine water analyses of the main cooling tower showed that the conductivity of the cooling water was 4.5 times the conductivity of the makeup water (4.5 cycles of concentration), system blowdown was started. The cycles of concentration were normally maintained between 4.5 and 5.0, which reduced the blowdown rate and the required amount of chemical additions to the system. Various chemicals were used in the cooling tower systems to prevent buildups of unwanted contaminants. These chemicals were derived from the processes describe under section 2.4.1.1 above. The blowdown from the system drained to the Industrial Waste Pond through a series of unlined ditches (Figure 1-2, 01 and 01A). These ditches continually had water in them, with flows increasing during EBR-II reactor runs, which used the main cooling tower. With the shutdown of the EBR-II reactor in October 1994 the main cooling tower has been out of service. Since then, the cooling tower basin has also been drained.

2.4.3 The ANL-W Interceptor Canal (ANL-09)

The ANL-W Interceptor Canal was used to transport industrial waste to the Industrial Waste Pond and to divert spring runoff and other natural waters around the ANL-W facility for flood control. Between 1962 and 1975, two 4-in. pipes transported liquid industrial wastes and cooling tower effluent to the Interceptor Canal. One line transported cooling tower blowdown water and regeneration effluent while the other line originated at the Industrial Waste Lift Station (ANL-31) and transported industrial wastes. Liquid radioactive wastes were discharged through the same line as the industrial wastes, but they were diverted to the EBR-II Leach Pit. Discharge of industrial wastes ceased in 1973, and discharge of cooling tower blowdown water ceased in 1975.

During clean out operations at the Interceptor Canal in October 1969, abnormal background radioactivity was detected. Wastewater was diverted to an adjacent parallel ditch and radioactive liquid waste was accidentally discharged, resulting in contamination to the surface soils of the adjacent ditch (ANL-01 Ditch B). Additional radiation surveys in 1969, 1973, and 1975 showed that the entire length of the Interceptor Canal was contaminated. Approximately 3,471 m^3 (4,540 yd^3) of contaminated soil was identified. Approximately 139

m^3 (182 yd^3) was disposed at the RWMC from 1975 to 1976. Of the remaining soil approximately 809 m^3 (1,058 yd^3) were removed and stockpiled south of the site (this stockpiled soil has been evaluated as part of the OU 10-04 ROD). The rest of the contaminated soil was left in place. Another survey conducted in 1993 shown that two small areas had elevated readings above background. Therefore, additional soil sampling was done in 1994. These soil samples were analyzed for metals and radionuclides.

2.4.4 The Industrial Waste Lift Station Discharge Ditch (ANL-35)

The Industrial Waste Lift Station Discharge Ditch, also known as the North Ditch, is found inside the security fences. The ditch is approximately 152 m (500 ft) in length with a bottom width of 0.91–1.2 m (3–4 ft). At any one time, approximately 5–8 cm (2–3 in.) of water may be found in the ditch. The ditch receives industrial waste from all facilities at ANL-W, except the TREAT facilities. From 1959 through 1966 the North Ditch was part of a surface water runoff ditch. From 1966 to 1972 the North Ditch received industrial wastewater from the Instrument and Test Facility (Bldg. 772) and the Sodium Process Demonstration Facility (Bldg. 789). After 1972 when the Industrial Waste Lift Station (ANL-29), was installed, the North Ditch received waste from this lift station.

In 1988, soil was excavated from the North Ditch to relieve clogging in the ditch by vegetation. Analysis of soil samples from the ditch and from the excavated material show that all metals except beryllium were below risk-based concentrations. In addition, low levels of VOCs, dioxin/furans, and herbicides were detected. The soil was boxed and disposed at the bulky waste landfill at the INEL in August 1993. Additional soil samples from the ditch were collected in 1994. The risk assessment for these samples shows risks at the lower limit of the NCP target risk range (i.e., 1×10^{-6}).

2.4.5 The Cooling Tower Riser Pits (ANL-53)

The Cooling Tower Riser Pits are found approximately 3 m (10 ft) east of the Main Cooling Tower. Each of the four pits is approximately 3.7 m (12 ft) deep with 23–38 cm (9–15 in.) of soil covering the rock bottom. During winter shutdown periods of the Main Cooling Tower, the riser pipes must be drained to prevent damage caused by freezing and the riser pits are used to collect this discharge. Soil samples were collected in 1989 at each of the riser pits and the north and south discharge pipes. The risk assessment done in the Track 2 Preliminary Scoping Package shows that the risk to human health is less than the lower limit of the NCP target risk range.

3.0 REGIONAL SETTING

This section presents regional information on the INEL as a whole. Characteristics of the uppermost water-bearing units beneath the INEL site, and regional physiographic, geologic, and hydrologic settings of the INEL are summarized in the following sections. This information has been assembled from several existing documents including Robertson et al. (1974), and Pittman et al. (1988).

3.1 Regional Demographics

The INEL is in southeastern Idaho, roughly equidistant from Salt Lake City, Utah (351 km; 211 mi), Butte, Montana (357 km; 214 mi), and Boise, Idaho (428 km; 257 mi) (Table 3-1). A total of 14 Idaho counties are found in part or entirely within 80 km (50 mi) of the INEL (see Figure 3-1 and Table 3-1). The INEL includes portions of five counties (Bingham, Bonneville, Butte, Clark, and Jefferson).

The largest population centers near the INEL are to the southeast and east along the Snake River and Interstate Highway 15. The largest communities closest to the boundaries of the INEL include Idaho Falls (43,929 persons in 1990), which is about 35 km (22 mi) east of the nearest Site boundary; Blackfoot (9,646 persons in 1990), about 37 km (23 mi) southeast of the nearest Site boundary; Pocatello (46,080 persons in 1990), about 60 km (37 mi) south-southeast of the nearest Site boundary; and Arco (1,016 persons in 1990), about 11 km (7 mi) west of the nearest Site boundary. Atomic City (25 persons in 1990), which is within about 0.8 km (0.5 mi) of the southern boundary of the INEL, is the closest town (EG&G Idaho, 1984).

A total of 8,294 persons were employed at the INEL as of December 1995. Of these, 4,851 regularly work at the INEL Site, and 3,443 regularly work at facilities in Idaho Falls, Idaho. A summary of the number of employees working at the INEL Site is given in Table 3-2.

The primary off-site concern, for the purposes of this report, is the use or consumption of water from the SRPA on-site or down gradient of the INEL. This is because groundwater is the primary source of water for both on-site facilities and down gradient neighbors of the INEL. All water used at the INEL is pumped from the SRPA. Water is used at the INEL for production, cooling, and domestic purposes.

The SRPA is the primary source of water down gradient of the INEL. The primary uses of water down gradient of the INEL include domestic consumption, irrigation, and stock watering. Eight counties are, at least in part, hydrologically down gradient of the INEL (see Table 3-3). Twenty-four centers of population are down gradient of the INEL. Each of the larger communities obtains their drinking water supply from the SRPA. Except Lincoln and Twin Falls counties, most of the down gradient population is found in rural areas. It is assumed that all drinking water consumed in the rural areas is derived from the SRPA also.

Table 3-1. Population of counties and places within 80 km (50 mi) of the INEL boundary.[a]

County	Place[b]	Population (1990)
Bannock		66,026
	Chubbuck	7,791
	Inkom	769
	Pocatello	46,080
Bingham		37,583
	Aberdeen	1,406
	Atomic City	25
	Basalt	407
	Blackfoot	9,646
	Firth	429
	Shelley	3,536
Blaine		13,552
Bonneville		72,207
	Ammon	5,002
	Idaho Falls	43,929
	Iona	1,049
	Ucon	895
Butte		2,918
	Arco	1,016
	Butte City	59
	Moore	190
Clark		762
	Dubois	420
	Spencer	11
Custer		4,133
	Mackay	574
	Lost River	29
Fremont		10,937
	Newdale	377
	Parker	288
	St. Anthony	3,010
	Teton	570

Table 3-1. (continued).

County	Place[b]	Population (1990)
Jefferson		16,543
	Hamer	79
	Lewisville	471
	Menan	601
	Mud Lake	179
	Rigby	2,681
	Ririe	596
	Roberts	557
Lemhi		6,899
Lincoln		3,308
Madison		23,674
	Rexburg	14,302
	Sugar City	1,275
Minidoka		19,361
	Minidoka	67
Power		7,086
	American Falls	3,757

a. 1990 census data.

b. The word "place" is defined by the Census Bureau as a census-designated place (CDP) or an incorporated place. CDPs comprise densely settled concentrations of population that are identifiable by name, but are not legally incorporated places. State and local census statistical committees have identified and delineated boundaries for CDPs. Other small population concentrations with names identified on maps may be found within the 80 km (50 mi) distance from the INEL boundary, but they are not recognized as a place by the Census Bureau. The population of those areas would be included only in the total county population. Total county population has been noted, but only portions of some counties fall within the 80 km (50 mi) distance (Figure 3-1).

Figure 3-1. Snake River Plain Aquifer and communities down gradient from the INEL.

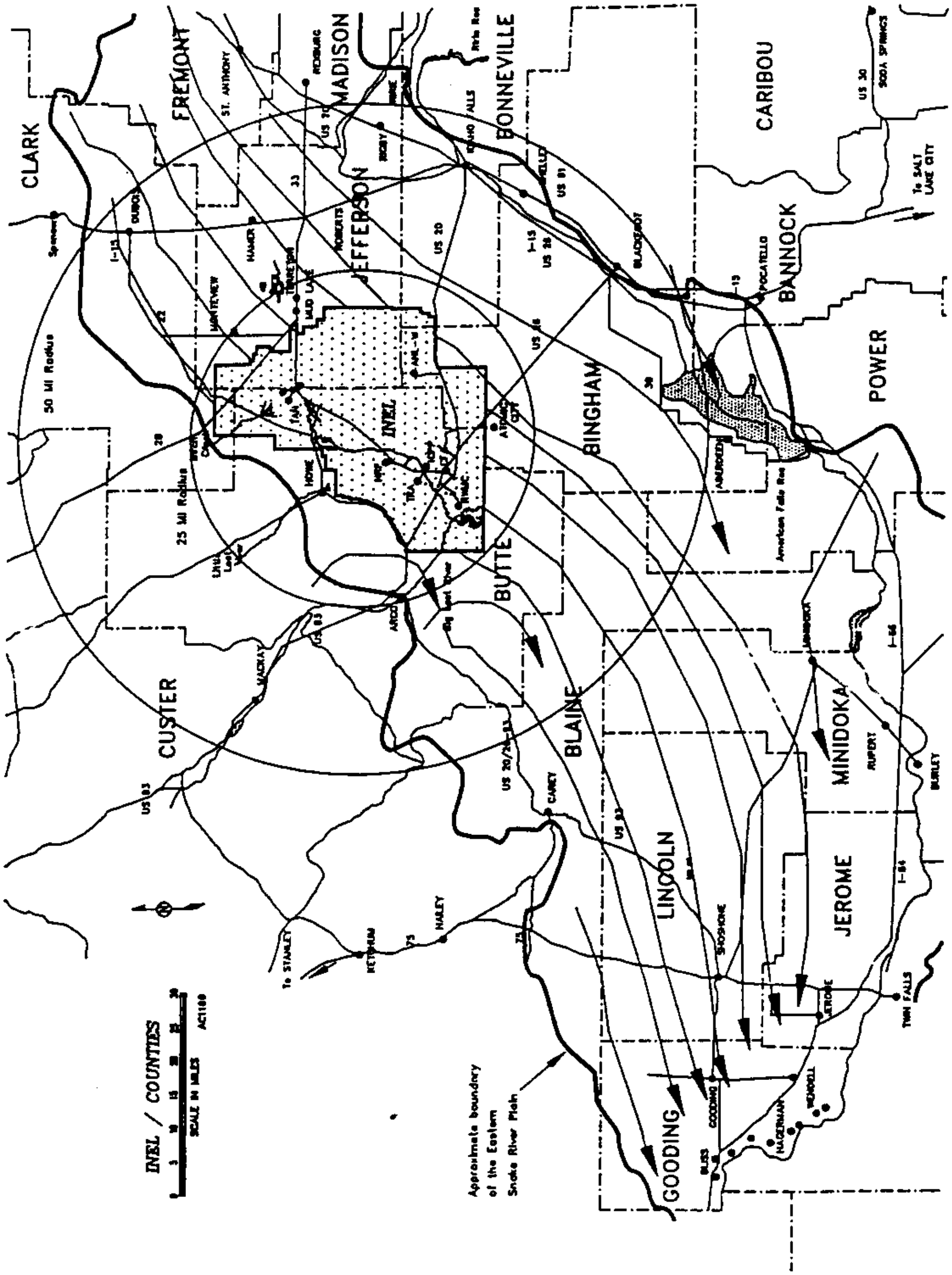


Table 3-2. INEL Site population by area.[a]

Argonne National Laboratory - West	739
Auxiliary Reactor Area	0
Central Facilities Area	854
Idaho Chemical Processing Plant	1,163
Naval Reactors Facility	1,026
Power Burst Facility	110
Radioactive Waste Management Complex	186
Test Area North	340
Test Reactor Area	433
Total Employees at the INEL	4,851

a. All numbers are based on the *INEL Headcount Report,* as of December 1995.

Table 3-3. Population of counties and places hydrologically down gradient of the INEL.[a]

County	Place[b]		Population	% of county population[c]	Distance from INEL boundary
Bingham			37,583		
	Atomic City 1 km (<1 mi)		25		
		Subtotal	25	.1%	
Butte			2,918		
Blaine			13,552		
Gooding			11,633		
	Bliss		185		155 km (96 mi)
	Gooding		2820		135 km (84 mi)
	Hagerman		600		155 km (96 mi)
	Wendell		1,963		145 km (90 mi)
		Subtotal	5,568	48%	
Jerome			15,137		
	Eden		314		126 km (78 mi)
	Hazelton		394		122 km (76 mi)
	Jerome		6,529		135 km (84 mi)
		Subtotal	7,237	48%	

Table 3-3. (continued).

County	Place[a]		Population	% of county population[c]	Distance from INEL boundary
Lincoln			3,308		
	Dietrich		127		106 km (66 mi)
	Richfield		383		90 km (56 mi)
	Shoshone		1,249		114 km (71 mi)
		Subtotal	1,759	53%	
Mindoka			19,361		
Twin Falls			53,580		
	Twin Falls		25,591		143 km (89 mi)
		Subtotal	25,591	48%	
TOTAL (population of places)			40,180		

a. 1990 census data.

b. The word "place" is defined by the Census Bureau as a census-designated place (CDP) or an incorporated place. CDPs comprise densely settled concentrations of population that are identifiable by name, but are not legally incorporated places. State and local census statistical committees have identified and delineated boundaries for CDPs. Other small population concentrations with names identified on maps may be found within the 80 km (50 mi) distance from the INEL boundary, but they are not recognized as a place by the Census Bureau. The population of those areas would be included only in the total county population. Total county population has been noted, but only portions of some counties fall within the 80 km (50 mi) distance (Figure 3-1).

c. The number represents the percent of county population that resides only within the places listed on the table.

Distances were scaled from the Delorme Idaho Atlas using an engineer's scale.

3.2 Regional Physical Setting

3.2.1 Physiography

The INEL is in the north-central part of the eastern Snake River Plain (ESRP). The ESRP is the eastern segment of the Snake River Plain and extends from the Hagerman-Twin Falls area northeast toward the Yellowstone Plateau (Figure 3-2). The ESRP is bounded on the northwest and southeast by the north to northwest-trending fault-block mountains of the Basin and Range physiographic province. The southern extremities of the Lost River and Lemhi Ranges and the Beaverhead Mountains extend to the western and northwestern borders of the INEL. At the base of the mountain ranges, the average elevation of the INEL is about 5,000 ft above mean sea level. Individual mountains immediately beside the plain rise to elevations of 10,830 ft above mean sea level.

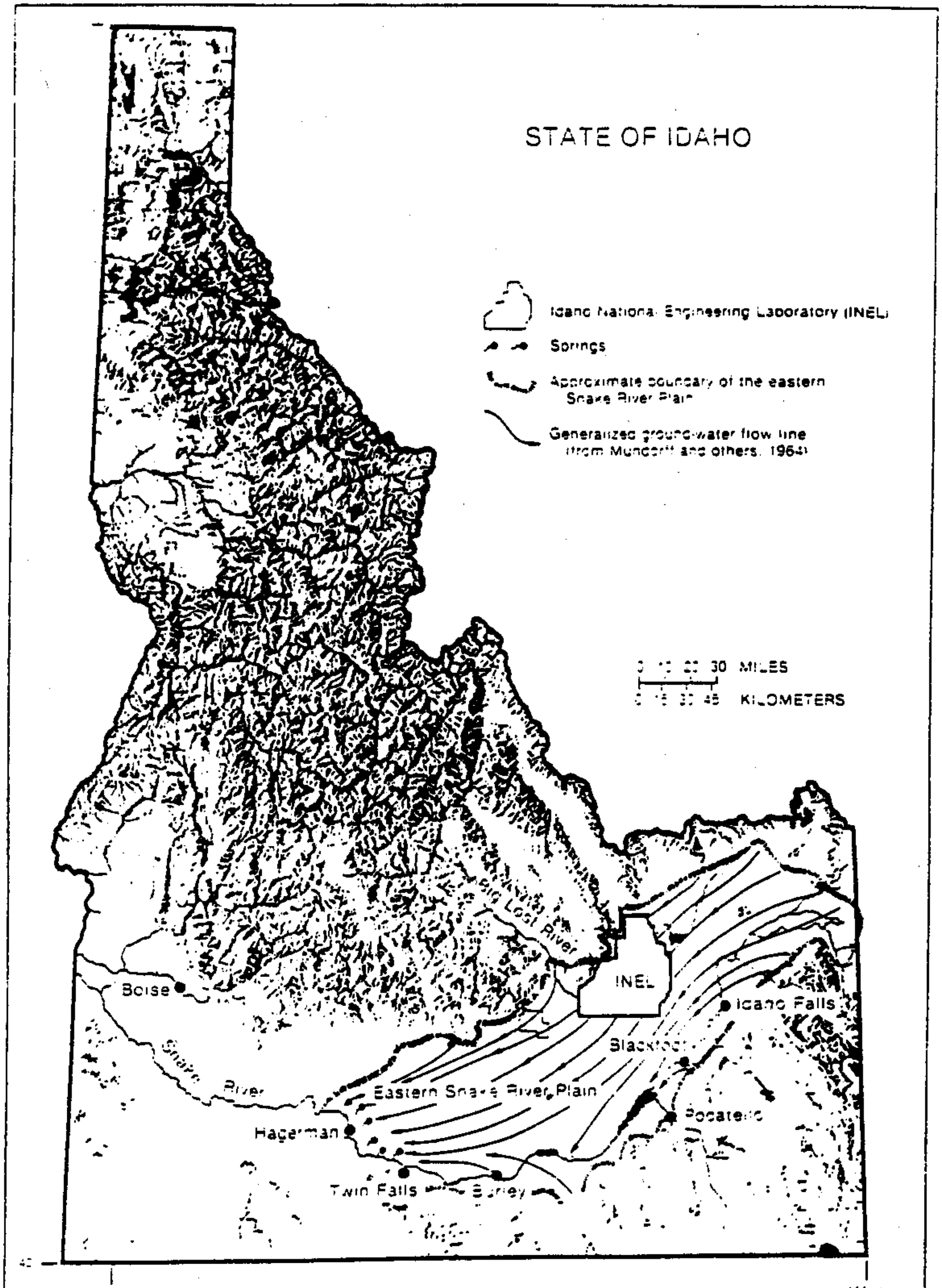
The surface of the ESRP is rolling to broken and is underlain by basalt with a thin, discontinuous covering of surficial sediment. Hundreds of extinct volcanic craters and cones are scattered across the surface of the plain. Craters of the Moon National Monument, Big Southern Butte, Twin Buttes, and many small volcanic cones are aligned generally along a broad volcanic ridge trending northeastward from Craters of the Moon toward the Mud Lake basin (Nace et al., 1972). Between this ridge and the northern edge of the plain is a lower area from which there is no exterior drainage. The INEL occupies a substantial part of this closed topographic basin.

The INEL covers an area of approximately 2,307 km^2 (890 mi^2). It is approximately 63 km (39 mi) long in a north-south direction and 58 km (36 mi) wide at its widest point. The topography of the INEL, like that of the entire Snake River Plain, is rolling to broken. The lowest area on the INEL is the Birch Creek Sinks at an elevation of 1,455 m (4,774 ft) above mean sea level. The highest elevations occur at East Butte, 2,003 m (6,572 ft) above mean sea level, and Middle Butte, 1,948 m (6,391 ft) above mean sea level.

3.2.2 Climatology

Physiography is very important to the climatology of the INEL (Clawson et al., 1989). The mountains to the west and north of the INEL deflects moisture-laden air masses upward creating an arid to a semiarid climate on the downwind side of the mountains. The climate is characteristically warm and dry in the summer and cold in the winter. The relatively dry air and infrequent low clouds permit intense solar heating of the surface during the day and rapid radiational cooling at night. The northeast-southwest orientation of the ESRP and the bordering mountain ranges tend to channel the west winds that prevail regionally so that a southwest wind predominates over much of the INEL (Figure 3-2). The second most frequent wind direction is from the northeast.

Figure 3-2. Location of INEL and Eastern Snake River Plain Aquifer (after Barraclough et. al., 1981)



Meteorological data have been collected at more than 45 locations on and near the INEL since 1949. The weather station at the CFA has more than 35 years of records for air temperature and precipitation. A weather station at TAN was operated from 1950 to 1964. Other smaller stations have been used periodically across the Site. The following climatological data came from a National Oceanic and Atmospheric Administration report by Clawson et al. (1989). Average annual precipitation amounts at CFA and TAN are 22.12 cm (8.71 in.) and 19.94 cm (7.85 in.), respectively. The maximum daily precipitation was 4.17 cm (1.64 in.) at CFA and 4.52 cm (1.78 in.) at TAN over the period of record. Thunderstorms cause a pronounced precipitation peak in May and June at both CFA and TAN, with an average of 3.1 cm (1.2 in.) at CFA and 3.3 cm (1.3 in.) at TAN for each of these months. The maximum 1-hr precipitation, over the period of record, was 1.37 cm (0.54 in.) at CFA and 2.92 cm (1.15 in.) at TAN, again due to thunderstorms.

Snowfall is a substantial contributor to total annual precipitation. Snowfall and snow depth records are available only for CFA. The annual average snowfall is 70.1 cm (27.6 in.), with a maximum yearly snowfall of 151.6 cm (59.7 in.) in 1971. The maximum average monthly snowfall is 16.3 cm (6.4 in.), occurring in December. The maximum monthly snowfall during the period of record was 56.6 cm (22.3 in.), occurring in December 1971. The maximum 24-hr snowfall was 21.8 cm (8.6 in.), and it occurred in March 1973. The water content of melted snow probably contributes between one-quarter and one-third of average annual precipitation

Surface air temperatures at the INEL are measured at CFA and TAN. A third station at the ANL-W area has been in operation since 1964. A 30-year average of air temperatures at TAN cannot be calculated directly because the period of record is only 15 years. To overcome this deficiency, the existing TAN temperature data were supplemented with data normalized using temperatures recorded at nearby off-site stations to show a full 30-year period of record. This was done according to standard National Climatic Data Center procedures.

Average daily air temperatures for the CFA range from a low of -12°C (10°F) on January 2, to a high of 21°C (70°F) on several days in late July. The 30-year normalized average daily air temperature at TAN ranges from -11°C (13°F) during mid-January to 21°C (70°F) during the latter half of July. The maximum air temperature recorded at CFA was 38°C (101°F). The minimum was -44°C (-47°F). The maximum and minimum air temperatures recorded for TAN were 39°C (103°F) and -45°C (-49°F), respectively.

The average annual temperature at the Site exhibits a gradual seven-month increase beginning with the first week in January and continuing through the third week in July. The temperature then decreases over a period of five months until the minimum average temperature is again reached in January. A winter thaw has occurred on several years in late January. This thaw has often been followed by more cold weather until the spring thaw.

Wind speed and directions (always recorded as the direction from which the wind is blowing) have been continuously monitored at many stations on and surrounding the INEL since 1950 (Clawson et al., 1989). The orientation of the bordering mountain ranges and the general northeast trend of the ESRP exert a strong influence on wind direction. Eastern Idaho lies in a region of prevailing westerly winds. Channeling of these winds within the ESRP usually produces a west-southwest or southwest wind at most locations on the INEL. The highest and lowest average wind speeds at the CFA occur in April [15.0 km/hr (9.3 mph)] and December [8.2 km/hr (5.1 mph)], respectively. The highest hourly average wind speed measured at the CFA was 108 km/hr (67 mph), from the west-southwest or southwest.

3.2.3 Geology

The ESRP is a broad structural depression filled with silicic and mafic volcanic rocks. It extends in a swath 80 to 112 km (50 to 70 mi) wide across southeastern Idaho from the Twin Falls area to Yellowstone National Park in northwest Wyoming. Its northeast trend cuts across the northwest-trending structures that otherwise prevail in the northern Basin and Range physiographic province.

3.2.3.1 Regional Geologic History

The development of the ESRP began in the middle Pliocene period with eruption of silicic volcanics near the southwest end of the plain. During development of the ESRP, silicic volcanic activity may have been confined to a relatively restricted portion of the plain at any given time, but the area of active volcanism gradually migrated northeastward (Hackett et al., 1986). The migration of the center of active volcanism is marked by a series of collapse calderas, which are progressively younger to the northeast. Rocks of the Blue Creek Caldera, whose projected outline roughly coincides with the INEL, are approximately 5.6 million years' old. The Kilgore Caldera of the Rexburg area is 4.3 million years' old. The youngest and northeasternmost of the calderas is the Yellowstone Caldera, which is approximately 800,000 years old (Hackett et al., 1986).

Although the preceding discussion was framed concerning the northeastward movement of a center of volcanism, current thinking is that the series of collapse calderas beneath the ESRP, getting younger to the northeast, traces the southwestward movement of the North American crustal plate over a persistent, localized, deep-seated source of molten rock (Leeman, 1982). Since volcanic activity began at the southwest end of the ESRP, the rate of movement of the plate over the deep-seated "hotspot" has averaged 1.4 cm/yr (0.55 in./yr) (Embree et al., 1982).

As the hotspot advanced to the northeast along the length of the ESRP, silicic volcanic activity at any given location subsided and was followed by mafic volcanism. Highly fluid molten basalt poured from rift zones and isolated vents, and flowed across the ESRP. Through the gradual accumulation of individual flows, a considerable thickness of basalt built up, which eventually engulfed and buried the landforms associated with the preceding period of silicic volcanism. The outpouring of basalt has continued until the recent past. Basalt flows encountered in the upper 200 m (700 ft) of wells drilled at the RWMC near the southern edge of the INEL yield ages ranging from approximately 100,000 to 600,000 years (Anderson and Lewis, 1989). The youngest flows in the ESRP occur at Craters of the Moon National Monument, with an age of approximately 2,100 years (Kuntz et al., 1986).

Three volcanic buttes lining the southern boundary of the INEL represent a late resurgence of silicic volcanic activity. Silicic volcanic rocks from Big Southern Butte and East Butte yielded potassium-argon (K-Ar) dates of approximately 300,000 to 500,000 years. Although silicic rocks do not outcrop on Middle Butte, the elevation and orientation of the basalt cap on the butte suggest that the cap was lifted and tilted by a hidden intrusion, presumably related to the silicic volcanics exposed in the neighboring buttes (Robertson et al., 1974).

Broad crustal down warping accompanied expulsion from the subsurface of the huge volumes of silicic and mafic volcanics that fill the ESRP. Evidence for this down warping is provided by the orientation of volcanic rocks along the margins of the plain (Robertson et al., 1974). These volcanic units dip toward the axis of the plain, and the oldest units show the steepest dips. Evidently, the floor of the ESRP continued to subside after these units were emplaced, and the oldest units have witnessed the largest amount of subsidence. Other evidence for subsidence of the floor of the ESRP comes from drill holes and geophysics, which show that rocks equivalent to the Paleozoic and Mesozoic sedimentary rocks exposed at the surface in the block-faulted mountains north and south of the ESRP have been depressed thousands of feet beneath the plain (Robertson et al., 1974).

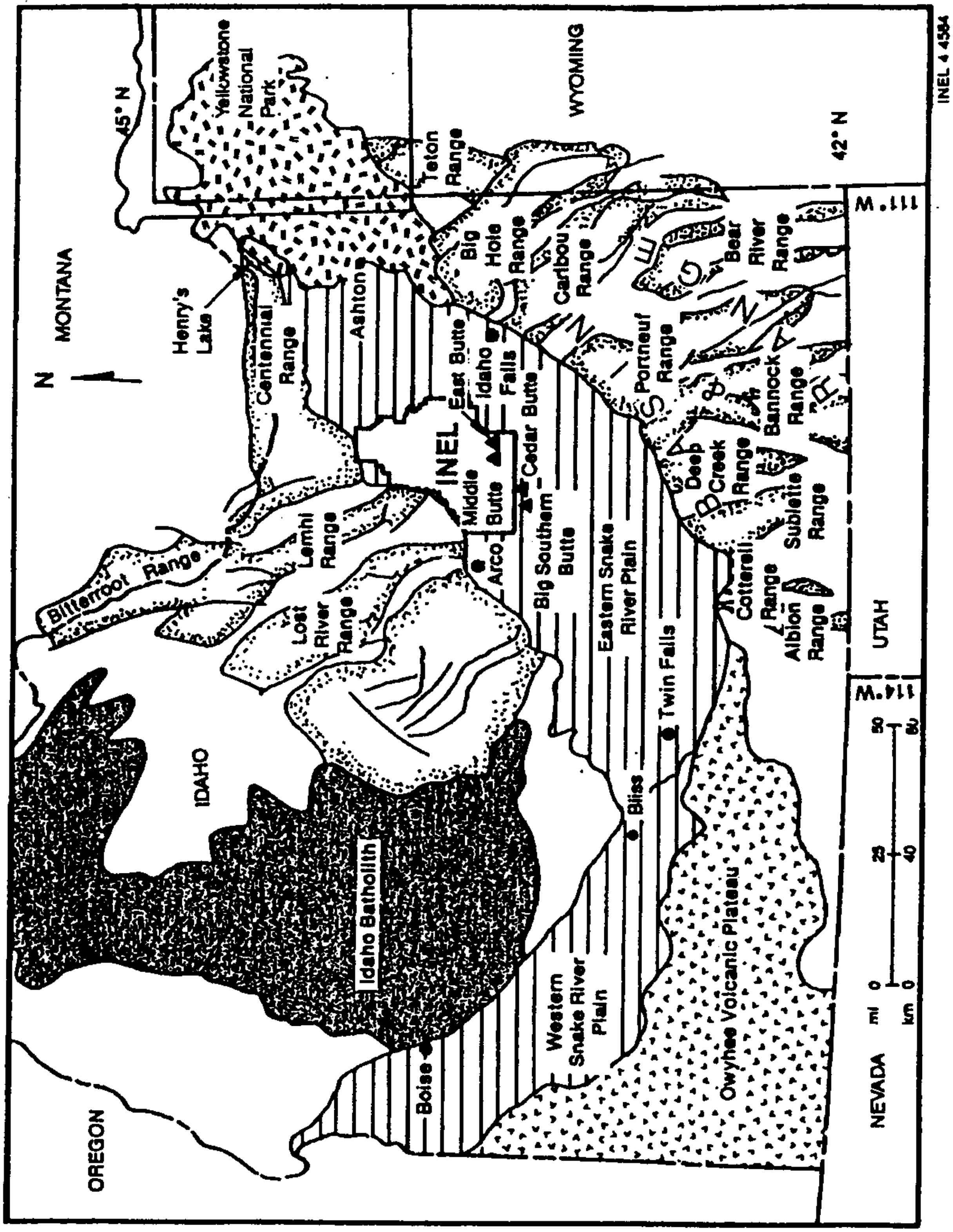
3.2.3.2 Geology of the INEL

Except for several silicic volcanic buttes, the INEL is underlain by basaltic lava flows, the youngest of which may be less than 100,000 years old. In many places the basalt is covered by a thin veneer of eolian, alluvial and lacustrine sediments. Figure 3-3 is a generalized map of the surficial geology of the INEL.

The thickness of basalt lava flows and interflow sediments beneath the INEL may vary from as little as 120 m (400 ft) to 760 m (2,500 ft) or more [based on geophysics in a well near the southern edge of the Site as reported by Robertson et al. (1974)]. The larger number is based on the thickness of basalt, 744 m (2440 ft), encountered in well INEL-1. The average thickness of the underlying silicic volcanics is unknown, but the same well penetrated 2,406 m (7,893 ft) of rhyolite ash flow tuffs, air fall ash, and volcaniclastic sediments (Doherty et al., 1979).

Basalts of the ESRP can be classified as olivine tholeites having low concentrations of silica and alkalis, and high concentrations of iron (Nace et al., 1956). Multiple flow units of the smooth, ropy variety of basalt (pahoehoe) are typical, but rough-textured aa flows also occur. Individual flows typically vary in thickness from about 3 to 75 m (10 to 250 ft). The basalt flows are interlayered with sediments, cinders, and breccia.

Figure 3-3. Surficial geology of the INEL.



Considerable variation in texture occurs within individual basalt flows (Nace et al., 1956). Usually, the bases of the flows are glassy to fine-grained and minutely vesicular. The middle portions are typically coarser grained, and contain fewer vesicles than flow tops or bottoms. The upper portions are fine-grained, highly fractured, and contain many vesicles. This distribution of textures within the flow results from rapid cooling of the upper and lower surfaces, and slower cooling of the interior. Another typical artifact of the slow cooling of the main mass of flow interiors is vertical hexagonal jointing, which results from the contraction of the rock that accompanies its cooling.

Basalt vents of the ESRP form linear arrays of fissure flows, small shields, cones, pit craters, and open cracks. These features define volcanic rift zones where eruptive activity has been concentrated. Several postulated northwest-trending volcanic rift zones cross the INEL (Nace et al., 1956). The youngest volcanism in this set of rift zones occurred at Hell's Half acre, south of the INEL, about 4,100 years ago.

Sedimentary interbeds represent quiescent periods between volcanic episodes, when the uppermost lava flow was covered by accumulations of eolian, alluvial, and lacustrine sediments (Nace et al., 1956). The sedimentary deposits display a wide range of grain size distributions depending on their mode of deposition, the source rock, and transport distance. The sediments seen in the interbeds accumulated in isolated depressions on the irregular surface of the basalt flows.

3.3.4 Hydrology

3.3.4.1 Surface Water Hydrology

Three surface drainages terminate within the boundaries of the INEL. Big Lost River, Little Lost River, and Birch Creek drain mountain watersheds found to the north and west of the Site (Figure 3-4). For more than 100 years, flows from the Little Lost River and Birch Creek have been diverted for irrigation, or have been lost to the subsurface because of high infiltration rates along the channel bed leading to the INEL. More recently, Birch Creek has been diverted for hydropower purposes. Birch Creek ends at a playa near the north end of the Site. The Little Lost River ends at a playa just north of the central northwestern boundary of the INEL. Surface water from the Birch Creek and Little Lost River watersheds has negligible impact on the INEL except during infrequent high-runoff events caused by the combination of rapid snowmelt and heavy precipitation.

The Big Lost River, the major surface-water feature on the INEL, drains more than 3,600 km^2 (1,400 mi^2) of mountainous area that includes parts of the Lost River Range and the Pioneer Range west of the INEL (Figure 3-4). The river flows onto the INEL near the Site's southwestern corner, bends to the northeast, and flows northeastward to the Big Lost River playas.

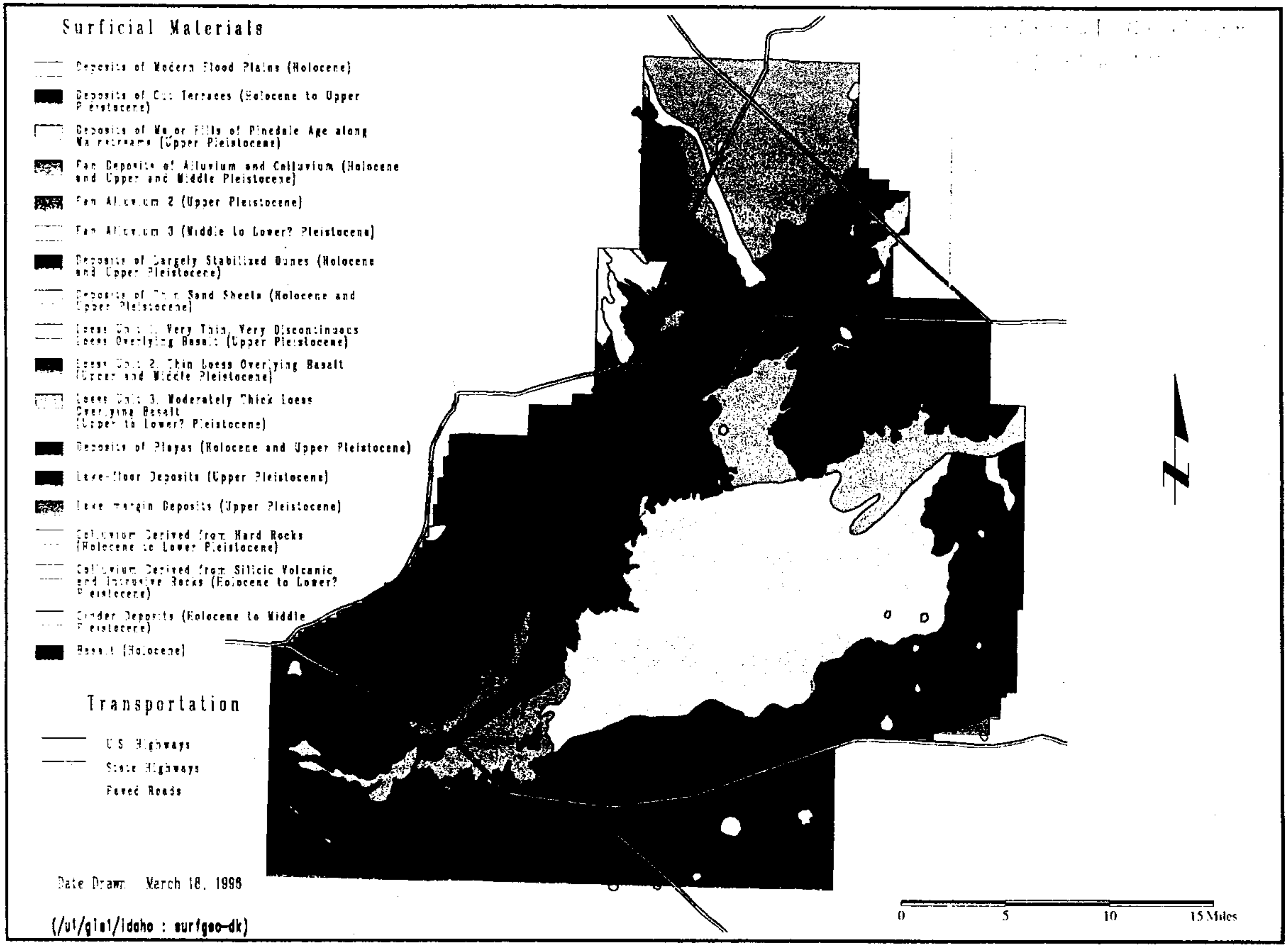
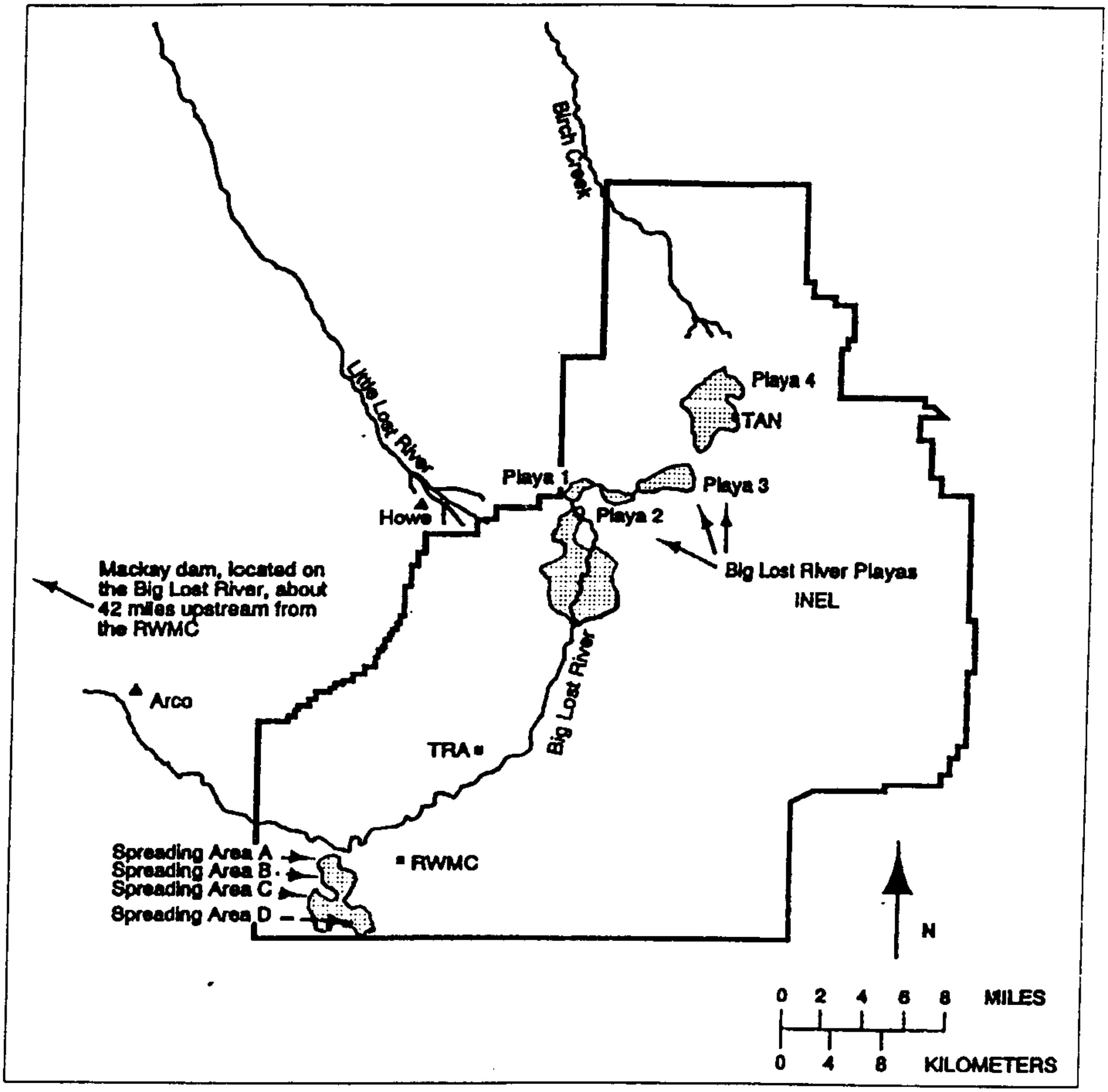

Surficial Materials
Deposits of Modern Flood Plains (Holocene)
Deposits of Cut Terraces (Holocene to Upper Pleistocene)
Deposits of Major Fills of Pinedale Age along Mainstreams (Upper Pleistocene)
Fan Deposits of Alluvium and Colluvium (Holocene and Upper and Middle Pleistocene)
Fan Alluvium 2 (Upper Pleistocene)
Fan Alluvium 3 (Middle to Lower? Pleistocene)
Deposits of Largely Stabilized Dunes (Holocene and Upper Pleistocene)
Deposits of Thin Sand Sheets (Holocene and Upper Pleistocene)
Loess Unit 1, Very Thin, Very Discontinuous Loess Overlying Basalt (Upper Pleistocene)
Loess Unit 2, Thin Loess Overlying Basalt (Upper and Middle Pleistocene)
Loess Unit 3, Moderately Thick Loess Overlying Basalt (Upper to Lower? Pleistocene)
Deposits of Playas (Holocene and Upper Pleistocene)
Lake-floor Deposits (Upper Pleistocene)
Lake-margin Deposits (Upper Pleistocene)
Colluvium Derived from Hard Rocks (Holocene to Lower Pleistocene)
Colluvium Derived from Silicic Volcanic and Intrusive Rocks (Holocene to Lower? Pleistocene)
Cinder Deposits (Holocene to Middle Pleistocene)
Basalt (Holocene)
Transportation
U.S. Highways
State Highways
Paved Roads
Date Drawn: March 18, 1998
(/ut/gis1/idaho : surfgeo-dk)
0
5
10
15 Miles
N

Figure 3-3

Figure 3-4. Surface water drainage features.



Diversion systems on the Big Lost River include Mackay Dam, several irrigation diversions between Mackay and Arco, and the INEL diversion dam. Mackay Dam is an earthfill structure 435 m (1,430 ft) long and 24 m (79 ft) high. Found approximately 65 km (40 mi) upstream from the INEL, Mackay Reservoir has a storage capacity of 54.9×10^6 m^3 (44,500 acre-ft) of water.

Flow in the Big Lost River at the INEL boundary is usually diminished by evaporation from Mackay Dam, irrigation diversions, and infiltration losses along the river channel. However, when runoff from the Big Lost River valley is heavy, flow may reach the INEL at its southwest boundary. From this point, flow moves northeastward in the natural channel of the Big Lost River, terminating at the playas near TAN. When flow exceeds 10,700 L/sec (377 cfs), some flow automatically is diverted from the channel to the INEL spreading areas, found 3 km (2 mi) northwest of RWMC. The diversion area consists of spreading areas A through D (Figure 3-4). When flow in the Big Lost River reaches the INEL, it is an important source of localized recharge to the SRPA.

The INEL diversion system and spreading areas were constructed in 1958 to divert high-runoff flows from the Big Lost River to protect downstream INEL facilities. The diversion system consists of a diversion dam, diversion channel, two gated culverts, 1.8 m (6 ft) in diameter, three dikes, four spreading areas, and two interconnecting channels. The dam and dikes were upgraded in the early 1980s to handle larger flow volumes. The diversion channel can carry 204 m^3/s (7,200 ft^3/s) from the river into the spreading areas (Bennett, 1986). Two low swales located southwest of the main channel can carry an additional 59 m^3/s (2,100 ft^3/s), producing a combined diversion capacity of 263 m^3/s (9,300 ft^3/s) (Bennett, 1986). Water diverted from the river enter the spreading areas, where it either evaporates or infiltrates the ground surface. Most of the water entering the spreading areas infiltrates the surface and eventually percolates to the aquifer (Wood, 1989a).

Discharge to the spreading areas is variable depending on the flow in the Big Lost River and the setting of the diversion gate. Spreading area discharge was highest during the mid to late-1960s and the mid-1980s (Orr and Cecil, 1991). Flow volume measured below Mackay Reservoir during 1965 was higher than that measured in any of the preceding 49 years (Barraclough et al., 1967). In 1965, the monthly discharge to the spreading areas peaked at about 43×10^6 m^3 (35,000 acre-ft) (Bennett, 1990). The volume of water diverted to the spreading areas in 1967 and 1969 approached that diverted in 1965. For several years following 1969, discharge to the spreading areas was much less. Then, starting in 1982, discharge to the spreading areas increased for several years, peaking in June 1984, with a discharge of nearly 62×10^6 m^3 (50,000 acre-ft) (Bennett, 1990). No diversions to the spreading areas occurred between 1987 and 1994. Flow in the Big Lost River had not reached the INEL since 1987. In June 1994 flow in the Big Lost did reach the INEL, and flowed as far north as the TRA/ICPP area. In 1995 flow onto the INEL was at its highest since 1987. Flow was recorded onto the INEL for approximately three months.

Besides runoff from the Big Lost River, local precipitation and surface runoff occasionally affect the INEL. INEL facilities, such as the RWMC, experienced flooding in 1962, 1969, and 1982 caused by local basin runoff (Karlsson, 1977; DeVries, 1983). These events were caused by rapid snowmelt combined with heavy rains, and often compounded by frozen-soil conditions.

3.2.4.2 Groundwater Hydrology.

3.2.4.2.1 Snake River Plain Aquifer The SRPA, part of which underlies the INEL, is approximately 320 km (200 mi) long and 48 to 97 km (30 to 60 mi) wide. It covers an area of about 24,600 km^2 (9,600 $mi^{2)}$ and serves as the water supply source for much of southeastern Idaho. Consequently it has been designated as a sole source aquifer by the EPA (56 FR 50634, October 7, 1991). The aquifer extends from near Ashton, Idaho, to Thousand Springs, near Twin Falls, Idaho, and is bounded by the less-permeable rocks of the mountains bordering the ESRP. The SRPA is one of the most productive aquifers in the United States (USGS, 1985). The aquifer may contain more than 1×10^{12} m^3 (1×10^9 acre-ft) of water (Barraclough, Lewis, and Jensen, 1981), and consist of a thick sequence of saturated basalts and sedimentary interbeds filling a large, arcuate, structural basin in southeastern Idaho.

The aquifer is composed of a series of basalt flows interbedded with sediment of eolian, fluvial, and lacustrine origin. Basalt permeability is controlled by pore spaces and fractures. The upper and lower contacts of successive basaltic flows typically have irregular fractures of variable size, fissures, and other voids. On a small scale (feet to hundreds of feet), the hydraulic properties of the basalt are nonuniform and highly variable, and the direction of groundwater movement at any given point within it is correspondingly variable and unpredictable. The presence of fine-grained, clayey, interflow deposits with hydraulic conductivities commonly 3 to 5 orders of magnitude lower than that of the surrounding fractured basalt will also impede the vertical movement of groundwater. Fracture joints in the central, commonly massive part of lava flows are typically vertical in nature. These fractures serve as the primary means in which groundwater moves vertically, through the otherwise impermeable basalt zones. On a larger scale, however, the aquifer can be considered more homogeneous. Regional flow direction within the aquifer is generally to the south and southwest, toward discharge points at springs along the Snake River in the Thousand Springs area. In 1988, a volume of approximately 5.3×10^9 m^3 (4.3 million acre-ft) of groundwater was discharged at these springs (Mann, 1986).

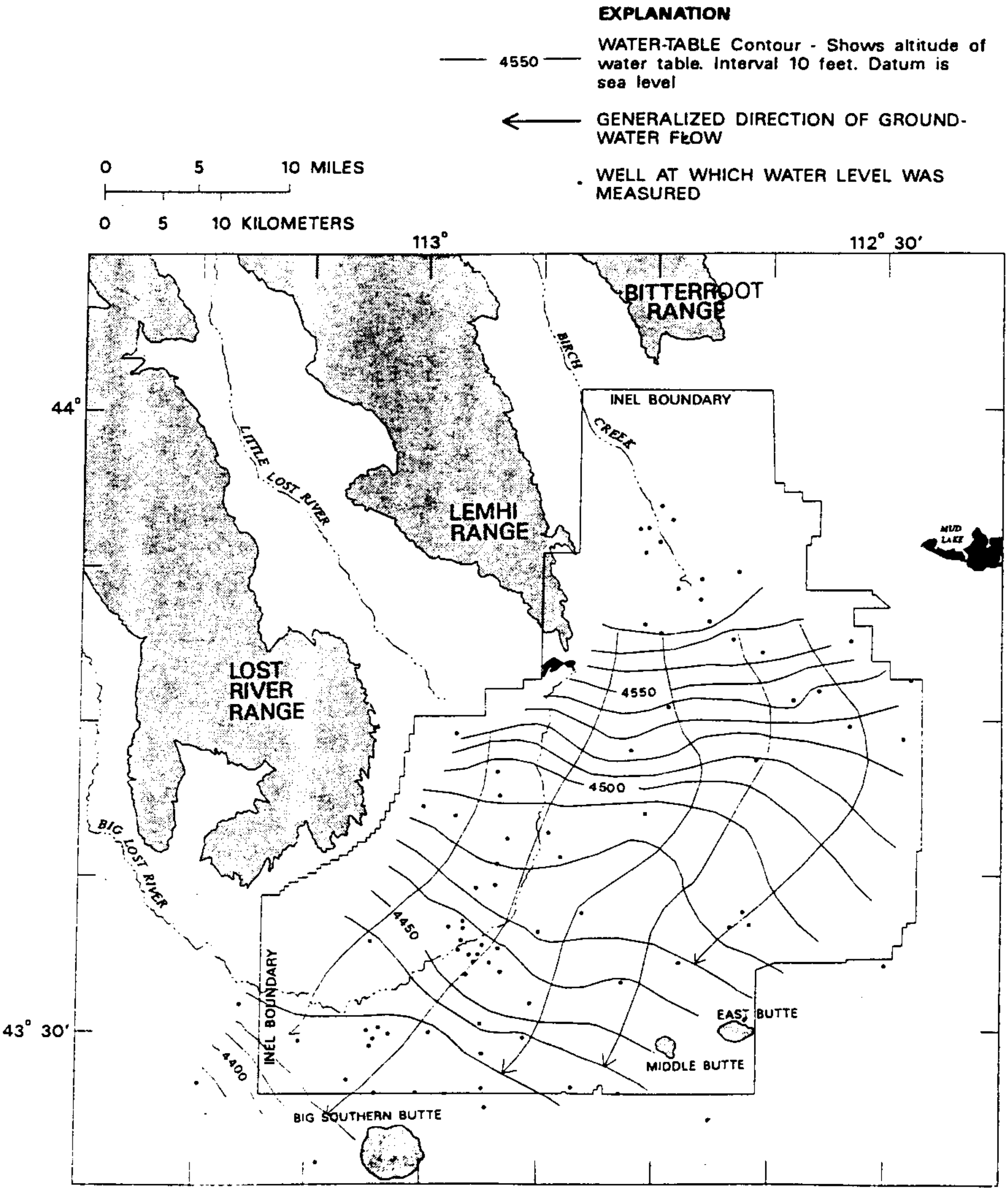
The portion of the SRPA beneath the INEL is typical of the aquifer overall. The depth to the aquifer at the INEL varies from about 60 m (200 ft) in the northern portion to more than 280 m (900 ft) at the Site's southeastern corner. As shown in Figure 3-5, the elevation of the water table in July 1988 was about 1,400 m (4,590 ft) near TAN and about 1,300 m (4,420 ft) near the RWMC (Orr and Cecil, 1991). Groundwater below the INEL flowed south and southwest. The average gradient of the potentiometric surface was approximately 0.75 m/km (4 ft/mi), and ranged from 0.2 to 2.8 m/km (1 to 15 ft/mi) (Figure 3-5). Data from Mundorff et al. (1964) suggest that groundwater flows at a rate of about 60 m^3/s (2,000 ft^3/s) beneath the INEL at its widest point. Robertson et al. (1974) calculated aquifer transmissivity for wells on the INEL in the range from 372 to 223,000 m^2/d (4,000 to 2,400,000 ft^2/d). The lower transmissivities were reported from wells near TAN, the highest from wells near TRA. A more recent evaluation of this and more recent data by Ackerman (1991) showed typical values for transmissivity at the INEL from 0.1 to 71,000 m^2/d (1.1 to 760,000 ft^2/d). Storage coefficients range from 0.01 to 0.06 (Robertson et al., 1974).

Significant vertical hydraulic gradients have not been observed in large-scale measurements within the active part of the SRPA. However, an upward hydraulic gradient is observed at greater depths (Mann, 1986). Mann (1986) concluded from data produced by the drilling of well INEL-1 that the effective base of the aquifer is 256 to 366 m (840 to 1,220 ft) below land surface. Since the depth to water near INEL-1 is approximately 120 m (400 ft), Mann's interpretation suggests that the thickness of the effective portion of the aquifer be between 134 and 250 m (440 and 820 ft). The hydraulic conductivity of basalts in the upper 244 m (800 ft) of the aquifer ranges from approximately 0.3 to 31 m/d (1 to 100 ft/d), generally diminishing with depth (Mann, 1986). Hydraulic conductivities of the underlying material are orders of magnitudes lower (0.009 m/d, 0.03 ft/d)(Mann, 1986). More recent analysis by Ackerman (1991) came up with a range of hydraulic conductivities from $8.6x10^{-3}$ ft/d to $5.5x10^{3}$ ft/d.

Detailed studies of flow within the basalts have shown that, on the scale of individual fractures, the vertical components of the hydraulic gradients may be locally upward in one well and downward over the same depth interval in an adjacent well, or both upward and downward in different parts of the same well (Barraclough et al., 1967). This suggests local control of groundwater movement by individual high-conductivity fractures or breccia zones, and reflects the heterogeneity of the aquifer

Inflow to the SRPA beneath the INEL is primarily by underflow from the northeastern part of the ESRP and by infiltration from the Big Lost River (Bennett, 1990). Groundwater levels near the river are influenced by recharge from the Big Lost River when it flows onto the INEL. Infiltration from the Little Lost River and Birch Creek to the north and west also adds lesser amounts of a recharge to the aquifer. Infiltration of direct precipitation on the INEL probably contributes a minor amount of recharge. Withdrawals by

Figure 3-5. Elevation of the water table, Snake River Plain aquifer, and general direction of groundwater movement, July 1991 (Bartholomay, R. C., et. al., 1995).



pumping at the INEL are small in comparison to the total volume of water stored in the aquifer and do not affect water levels significantly.

3.2.4.2.2 Perched Water Perched water is defined as a discontinuous saturated lens with unsaturated conditions existing both above and below the lens (Freeze and Cherry, 1979). Classical conceptualization of a perched water body implies a large, continuous zone of saturation capable of producing some amount of water. Perched groundwater exists beneath the INEL in areas where downward flow to the aquifer is impeded by layers of fine-grained sediments and by basalt flows with low permeability. Perched water occurs below the Big Lost River, and below wastewater discharge operations at TRA, ICPP, TAN, and NRF.

3.4.5 Regional Groundwater Quality

An accurate assessment of the impact of INEL operations on water quality in the SRPA depends on both baseline data and data produced by ongoing water quality sampling. Baseline water quality data must be gathered to allow discrimination between chemical parameter concentration levels that can be considered "normal" for the aquifer and higher levels suggesting contamination from DOE activities. Ongoing water quality sampling should be conducted in areas of known, suspected, or potential groundwater contamination. The USGS has for many years taken responsibility for gathering both kinds of water quality data at the INEL. The results of this work have been presented in many reports, the earliest of which were published as long ago as the early 1950s. Data from some of these reports are summarized below.

3.4.5.1 Baseline Water Quality Data

Schoen, writing in Robertson et al. (1974), compiled analytical results from water quality analyses conducted before the initiation of large-scale activities at the National Reactor Testing Station (NRTS), as the INEL was once known. Much of the data comes from the early 1950s. The sample collection procedures and analytical methods then in use were less advanced than their modern counterparts. However, the internal consistency of this information and its general agreement with more recent results suggest that it is sufficiently reliable to be used to define broad trends in the natural quality of groundwater at the INEL.

Table 3-4 shows, for several parameters, mean values and ranges of values for the "best available chemical analyses" of water samples collected from 69 wells in the vicinity of the NRTS before the beginning of large-scale operations. Beyond reporting the data summarized in Table 3-4, Schoen plotted the data to show variations in the concentrations of dissolved constituents across the Site. Schoen related the observed variations in water quality to corresponding variations in bedrock in the surrounding drainage basins that contribute recharge to the aquifer, and to other factors.

The chemical composition of groundwater is controlled by the composition of the rocks with which it has come into contact. Higher-than-average values for calcium, magnesium, and bicarbonates were observed in the western half of the Site. These elevated values can be attributed to the passage of surface water, which recharges the SRPA from the northwest, through areas in which limestone and dolomite are the dominant bedrock lithologies. This hypothesis is supported by analysis of surface water samples from the major drainages west and northwest of the Site, which show elevated levels of the same constituents. Rhyolite volcanics are the dominant lithology in regions bordering the SRPA to the north and northeast. This is consistent with relatively elevated concentrations of sodium, fluorine, and silica in water samples from the east half of the Site (Robertson et al., 1974).

Other processes also have an influence on water quality in the SRPA. Intensive irrigation in the Mud Lake/Terreton area results in higher levels of total dissolved solids and other constituents in a restricted area on the east side of the Site. Irrigation is accompanied by a high level of evaporation, resulting in infiltration to the aquifer of water enriched in any dissolved constituents it already carried. Infiltrating irrigation water may also carry elevated levels of constituents such as sodium, which are especially easily leached from the soil. Relatively high levels of nitrate down gradient from the Mud Lake area can be linked to the use of fertilizer.

The relatively low level of total dissolved solids observed in the aquifer partly depends on proximity to recharge areas in the surrounding mountains, short geochemical reaction times, and the low solubility of the silicate minerals that predominate in the basalts of the aquifer.

Recent USGS studies have characterized baseline concentrations of selected constituents in groundwater at the INEL and in down gradient areas. Orr et al. (1991) studied baseline concentrations of selected radionuclides, organic compounds, and chemical constituents on and around the INEL. In essence, the constituents selected for study were those that might be expected to appear as groundwater contaminants related to activities at the INEL, and for which establishment of a baseline is critical. Tables 3-5 and 3-6 summarize some results of this report.

Table 3-5 lists concentrations of selected radionuclides in the SRPA. Most of the tabulated values represent the mean of analyses conducted on water samples collected from 12 wells and three irrigation wastewater drains in an area approximately 105 km (65 mi) southwest of the INEL. These samples can be assumed not to have been influenced by contaminants originating at the INEL. This is because flow rates in the SRPA are insufficient to have transported contaminants such a long distance from the Site in the time the INEL has been in operation. Natural background concentrations for some constituents are shown as zero because these constituents are not naturally occurring substances, and are found only in association with nuclear operations.

Table 3-4. Mean values and ranges for selected water quality parameters for samples from 69 wells (summarized from Robertson et al., 1974).[a]

Parameter	Range	Average
Temperature (°F)	49-65.5	55.0 (65)
pH	7.2-8.4	7.9 (68)
Specific conductance (micromhos @ 25°C)	225-963	358
Calcium	22-93	40.0
Magnesium	5.9-33	14.8
Sodium	2.7-42	11.4
Potassium	1.2-6.8	2.7
Bicarbonate	81-226	167.5
Sulfate	9.1-57	23.8
Chloride	6.0-160	15.7
Nitrate	0.5-29	2.6
Fluoride	0-0.9	0.3
Silica	11-39	25.1
Iron (dissolved)	0-0.52	0.08 (67)
Total hardness	94-368	161

a. Values in milligrams/liter unless otherwise indicated. Numbers in parentheses are number of samples in average if fewer than 69.

Table 3-5. Background concentrations of selected radionuclides in the Snake River Plain aquifer (Orr et al., 1991).

Constituent	Concentration (pCi/L)
Tritium	35 ± 13[a]
Potassium-40	300[c]
Cobalt-60	0[b]
Strontium-90	0[a]
Iodine-129	0 ± 0.05[a]
Cesium-137	0[b]
Radon-222	0 to 250[a]
Radium-226	0 to 0.1[a]
Radium-228	0 to 0.3[a]
Total uranium	3.0 ± 0.3[a]
Gross beta	0 to 8[a]
Gross alpha	0 to 5[a]

a. Median concentration in 12 wells and three irrigation wastewater drains 105 mi (65 mi) down gradient from the INEL.
b. Not a naturally occurring constituent of groundwater.
c. Estimate based on analysis for potassium and known relative abundance of K-40 isotope.

Table 3-6. SRPA baseline concentrations for selected inorganic constituents near the INEL (Orr et al., 1991).

Constituent	Natural baseline concentration for SRPA (μg/l)
Arsenic	2 - 3
Barium	50 - 70
Cadmium	< 1
Chromium	2 - 3
Lead	< 5
Mercury	< 0.1
Selenium	< 1
Silver	< 1
Fluoride	400 - 500
Nitrate (expressed as nitrate)	< 6,200

Table 3-6 provides baseline concentrations of ten inorganic constituents in the SRPA. These constituents were selected because maximum contaminant levels have been established for them (EPA, 1989).

Organic compounds that could be associated with industrial processes undertaken at the INEL include the following: benzene, bromoform, carbon tetrachloride, chloroform, dibromochloromethane, dichlorobromomethane, 1,4-dichlorobenzene, 1,2-dichloroethane, 1,1-dichloroethylene, 1,1,1-trichloroethane, trichloroethylene, and vinyl chloride. Some of these compounds have been detected in groundwater at the INEL.

A report by Wegner and Campbell (1991) provides analytical results for groundwater samples collected from 55 wells and springs down gradient from the INEL, between the Site's southern boundary and the major discharge zone at the Hagerman-Thousand Springs area. The samples were tested for a broad range of constituents, including selected radionuclides, trace metals, nutrients, surfactants, purgeable organic compounds, insecticides and polychlorinated compounds, and herbicides. The data revealed no detectable groundwater contamination in the SRPA down gradient from the Site that could be attributed to activities at the INEL. However, since the Wegner and Campbell report was published, I-129, and Cl-36 have been detected off-site in extremely small quantities (Mann and Beasley, 1994, Beasley, 1995).

3.4.5.2 Groundwater Contamination

Operations at the INEL have resulted in measurable groundwater contamination at several locations within the Site. The contamination in these areas has been described in a series of USGS studies that examined the influence of INEL operations on water quality since the 1950s. Examples of general reports include Robertson et al. (1974), Barraclough et al. (1976), Barraclough and Jensen (1976), Barraclough et al. (1981), Lewis and Jensen (1984), Pittman et al. (1988), and Orr and Cecil (1991). Besides this series of reports on general groundwater conditions, USGS also produced many reports devoted to individual contaminants or groups of contaminants of special interest:

- Mann and Knobel, 1987 (purgeable organic compounds)
- Mann and Knobel, 1988 (nine trace metals)
- Knobel and Mann, 1988 (radionuclides)
- Mann et al., 1988 (iodine-129)
- Mann and Cecil, 1990 (tritium)

INEL activities have resulted in elevated concentrations of several radiochemical and chemical constituents in water from the SRPA. These constituents include tritium, strontium-90, cobalt-60, cesium-137, plutonium, americium-241, chromium, sodium, chloride, sulfate, nitrate, and various volatile organic compounds. The horizontal distribution of these constituents in the aquifer has been estimated based on their concentration in wells. Vertical concentration variations are poorly known.

Water samples from zones of perched groundwater have also been collected and analyzed. Contamination of perched water has been documented at several locations.

Tritium released from INEL facilities has been present as a contaminant in the SRPA since the 1950s. The principal causes of tritium contamination have been subsurface injection of radioactively contaminated wastewater through the disposal well at ICPP and discharge of wastewater to infiltration ponds at both ICPP and TRA. Mann and Cecil (1990) produced a series of maps showing the development of the ICPP/TRA tritium plume with time. Changes in the shape and extent of the plume from one period to the next can be attributed to the direction of regional groundwater flow, changes in waste disposal practices, dilution of the wastes in the aquifer, and radioactive decay (Mann and Cecil, 1990).

Plumes of strontium-90, sodium, chloride, and nitrate have also appeared in the SRPA because of operations at ICPP and TRA. These plumes are less widespread than the tritium plume (Orr and Cecil, 1991).

Several radionuclides other than tritium and strontium-90 have been detected in wells completed in the SRPA at the INEL. Reportable concentrations of plutonium, cobalt-60, cesium-137, and americium-241 were measured in water samples collected from several wells in 1986 and 1988. Cobalt-60, cesium-137, and americium-241 were measured only in the TAN disposal well. Plutonium isotopes were measured in groundwater near both the TAN and ICPP disposal wells, and plutonium-238 was measured in water drawn from well CFA-1, downstream of the TRA/ICPP area.

Groundwater samples from 81 INEL wells were analyzed for total chromium in 1987 as part of a trace metal sampling program (Mann and Knobel, 1988). Chromium was detected at or above the maximum contaminant level of 50 $\mu g/L$ at some wells at RWMC and TRA.

Water samples from these 81 wells were also analyzed for 36 volatile organic compounds. The results showed that water in the SRPA locally contained detectable concentrations of 12 volatile organic compounds. The prevalent compounds were carbon tetrachloride, 1,1,1-trichloroethane, trichloroethylene, tetrachloroethylene, chloroform, toluene, 1,1-dichloroethylene, and dichlorodifluoromethane. Wells yielding water containing one of more of the twelve detected compounds are found at or near the ICPP, RWMC, TAN, CFA, and TRA.

4.0 LOCAL SETTING

This section presents information on the area around ANL-W. Characteristics of the uppermost water-bearing units beneath the ANL-W site, and local physiographic, geologic, and hydrologic settings of the ANL-W are summarized in the following sections. This information has been assembled from several sources including the INEL Groundwater Monitoring Plan, and results of recent drilling at the site.

4.1 Physiographic and Geomorphic Setting

The ANL-W facility is in the southeastern portion of the INEL (Figure 1-1), in sections 11, 12, 13, and 14 of T3N R32E. ANL-W is responsible for a roughly rectangular shaped administrative area encompassing approximately 893 acres. The ANL-W site itself occupies approximately 60 acres in the center of the administrative area. ANL-W facilities are within a local topographically closed-basin. The surface of the facility slopes gradually from south to north, at approximately 30 ft per mile. Maximum topographic relief within the ANL-W administrative boundary is about 50 ft, ranging from 5110 ft above mean sea level on the north boundary, to 5160 ft on a basalt ridge to the southeast.

4.2 Meteorology

As discussed in section 3.2.2, the U. S. Weather Bureau has operated a monitoring station at the Central Facilities Area (CFA) since 1949. A 250-foot tower is also located just outside the east security fence of the ANL-W area. This tower was installed in 1964 and therefore has not been in continuous operation for as long as the CFA station.

4.2.1 Air Temperature

Data has been collected from both two meters and ten meters above the ground surface at ANL-W. The two-meter data set is limited in time from August 1993 to July 1995. Because these data are collected from ANL-W, they are considered to more accurately portray surface conditions at the site. The maximum average temperature during the time of record was in July of 84.8°F. The minimum average temperature of 7.9°F was recorded in December. Table 4-1 shows monthly mean, maximum, and minimum temperatures for the time of record at ANL-W.

4.2.2 Precipitation

Precipitation and humidity are not measured at the ANL-W tower. However, the National Oceanic and Atmospheric Administration (NOAA) conducted an evaluation of CFA and ANL-W areas and determined that the use of the CFA data for these parameters is reasonable (Hukari, 1995). Precipitation at the CFA was measured as rainfall and snowfall for the period January 1950 to December 1988. During this period most of the precipitation was received in May and June and averaged 1.2 inches. The annual total average was 8.71 inches. As could be expected most snowfall occurred during December and January. The average snowfall event for December and January was 6.4 inches and 6.1 inches, respectively.

Table 4-1 Monthly Temperatures (8/93-7/95)

Month[a]	Mean[b]	Maximum[b]	Minimum[b]
January	22.5	31.6	12.9
February	25.1	36.7	13.8
March	35.1	48.4	22.1
April	42.9	56.2	27.8
May	52.1	65.2	37.1
June	59.3	73.7	41.0
July	67.2	84.8	46.5
August	65.3	83.3	44.7
September	57.0	75.7	36.2
October	41.8	56.6	27.5
November	22.7	35.4	8.9
December	19.8	29.0	7.9

[a] Time period August 1993 to July 1995.
[b] All values in degrees Farenhiet.

4.2.3 Evaporation and Infiltration

Wet bulb temperature humidity measurements from the CFA run from 1956 to 1961. The highest average occurred in the winter at 55%, a low average of 18% was recorded in the summer. Although NOAA does not measure pan evaporation at the INEL, adjusted Class A values have been made through regression analysis of other southeast Idaho sites. Data from 1950-51, 1958-59, 1963-64, and 1969-70 yielded an adjusted range of 40 to 46 inches per year. Other estimates for the INEL (Hull, 1989) have values of 36 inches per year from saturated ground, 32 to 36 inches per year from shallow lakes, and six to nine inches per year from native vegetation.

Evaporation rates calculated from the Industrial Waste Pond in 1995 give a range of 0.43 in/day to 0.10 in/day for summer and winter, respectively. Infiltration rates during the same period range form 0.36 in/day to 0.07 in/day.

4.2.4 Wind

Wind measurements at ANL-W are made at ten meters and 250 meters above the ground surface. Based on these data, ANL-W is clearly subject to the same southwest and northeast winds as the rest of the INEL. Monthly average wind roses for the period 1990 to 1994 are shown in Figure 4-1 through 4-12. Winds tend to be diurnal with up slope winds (those out of the southwest) occurring during the day and down slope winds (those out of the northeast) occurring at night. During the five-year time of record from 1990 to 1994 winds blew from the southeast 14% of the time, from the south-southwest 11% of the time, and from the northeast 10% of the time. Winds were calm during only 2.49% of the time on record.

4.2.5 Special Phenomena

A thunderstorm is defined by the National Weather Service as a day on which thunder is heard at a given station. According to this definition, lightning, rain and/or hail are not required during this time. Following this strict definition the ANL-W may experience two to three thunderstorm days from June to August. Thunderstorms have been observed during each month of the year, but only rarely from November to February. Thunderstorms on the INEL tend to be less severe than in the surrounding mountains because of the high cloud base above the plain. In many instances' precipitation from a storm will evaporate before reaching the ground.

Local thunderstorms may also be accompanied by "micro bursts." These micro bursts can produce dust storms and occasional wind damage. Thunderstorms may also be accompanied by both cloud-to-ground and cloud-to-cloud lightening.

Because no permanent, natural, surface waters are found near ANL-W, flooding is not a major concern. However, the facility has been inundated in the past by rapid snow melt events. To control this, a diversion dam was constructed south of the facility. This dam has a gate that, when closed, diverts water into the adjacent drainage and from there via the interceptor canal directly west of ANL-W into the IWP.

4.3 Geology

A regional geologic history of the Eastern Snake River Plain is discussed in section 3.2.3. This subsection describes the local geological characteristics at ANL-W. Where applicable, pertinent geological information, including geomorphology, stratigraphy, lithology, and bedrock structure, is also described.

Figure 4-1. Monthly average wind rose for January (1990 to 1994)

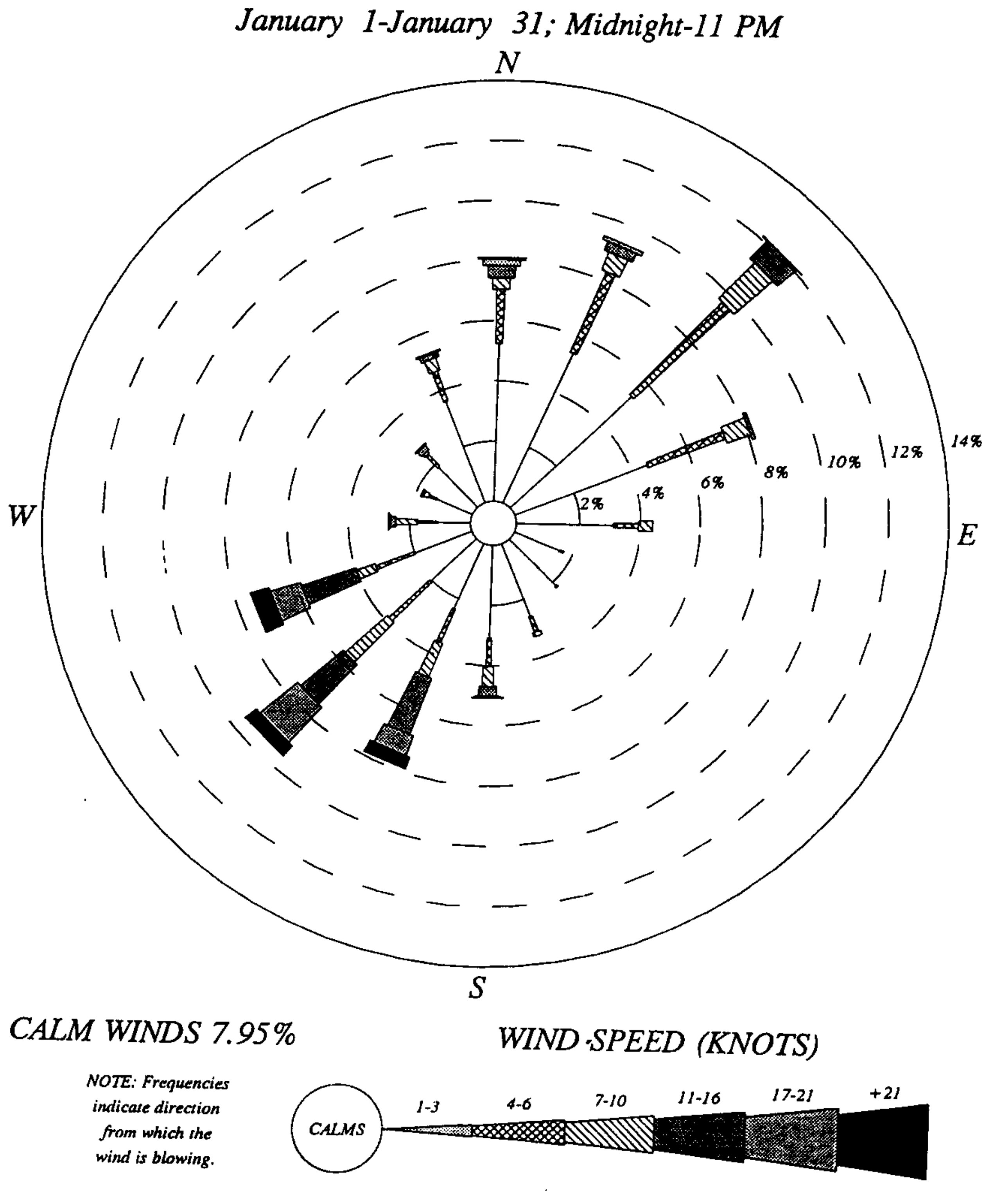


Figure 4-2. Monthly average wind rose for February (1990 to 1994)

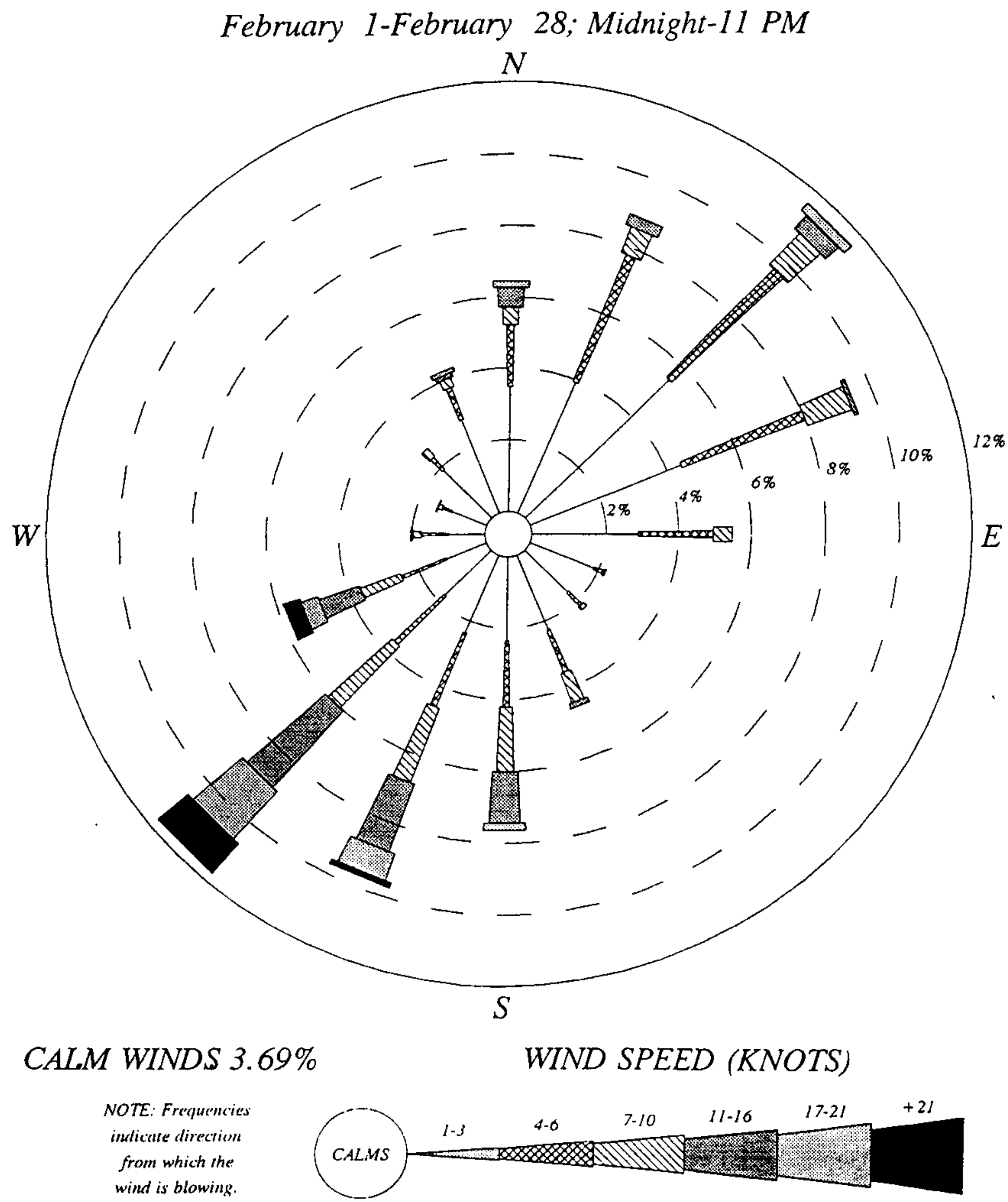


Figure 4-3. Monthly average wind rose for March (1990 to 1994)

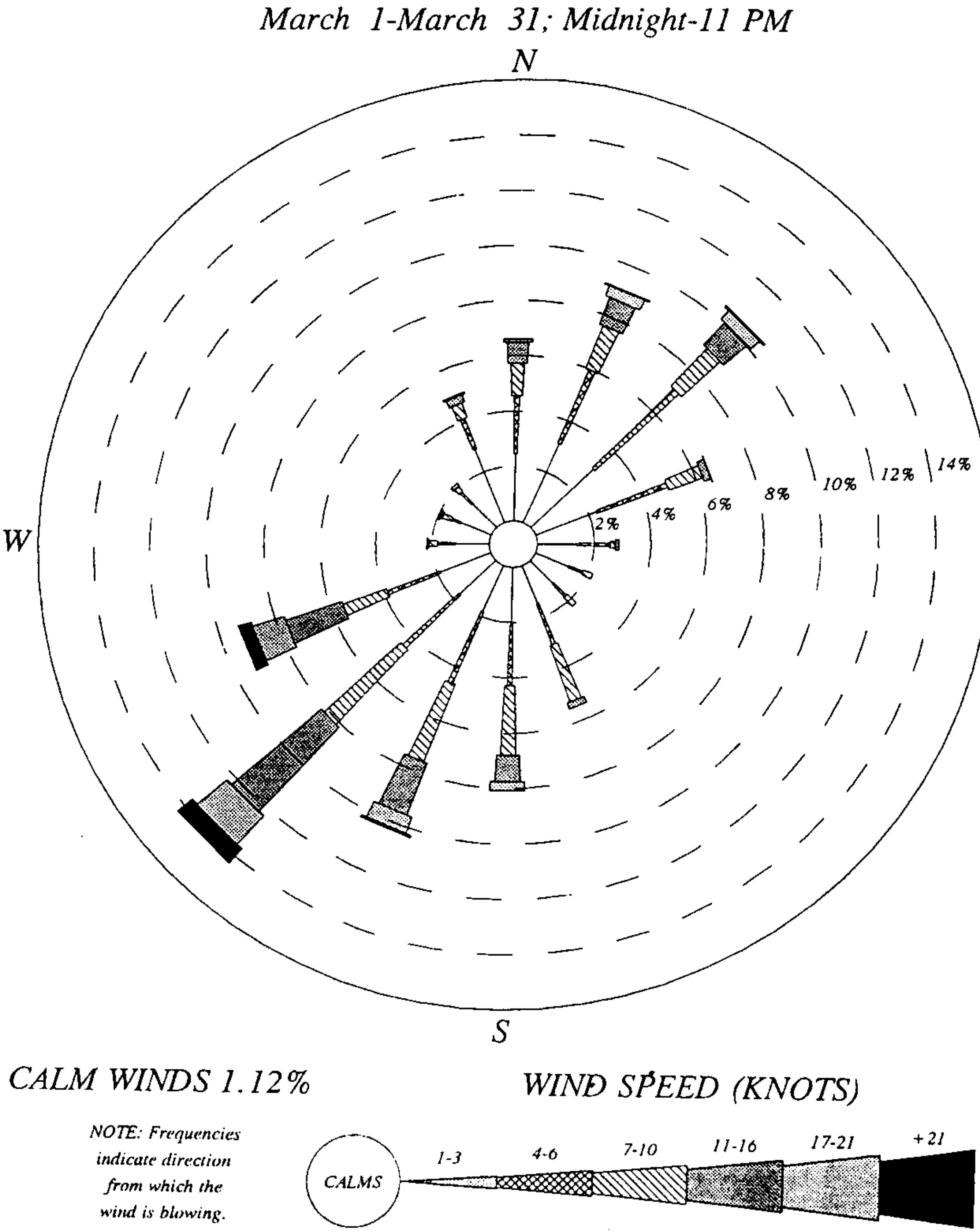


Figure 4-4. Monthly average wind rose for April (1990 to 1994)

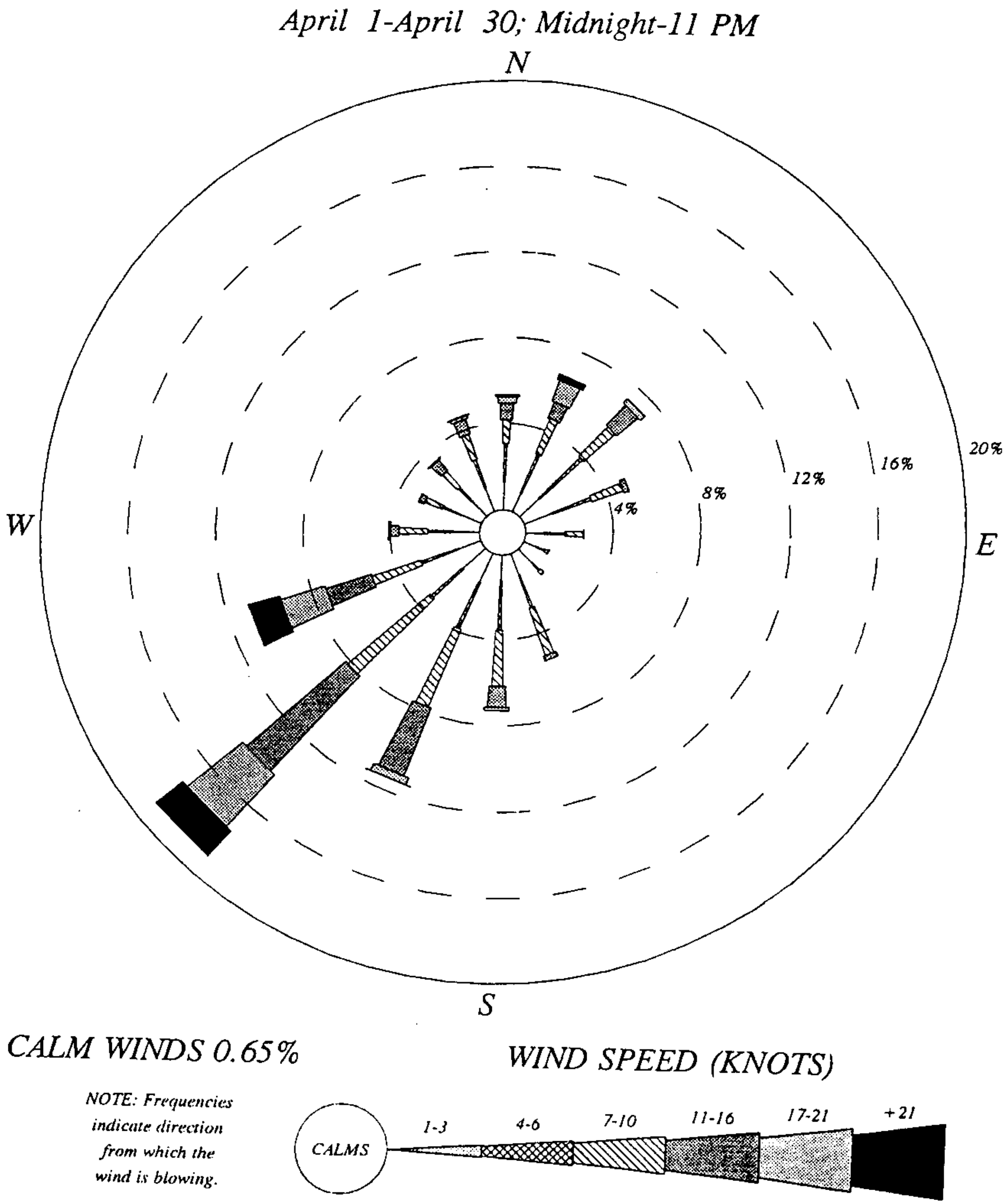


Figure 4-5. Monthly average wind rose for May (1990 to 1994)

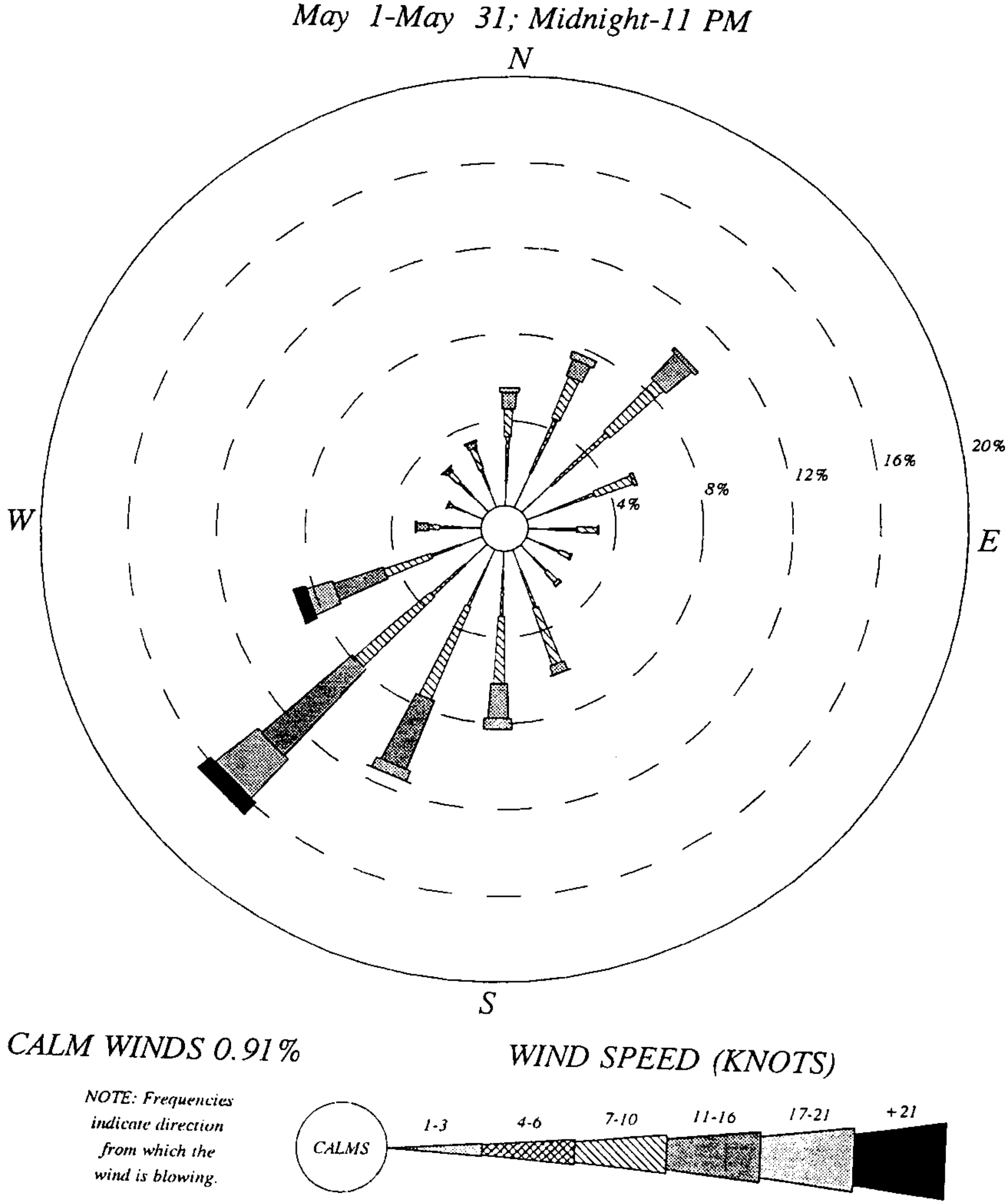


Figure 4-6. Monthly average wind rose for June (1990 to 1994)

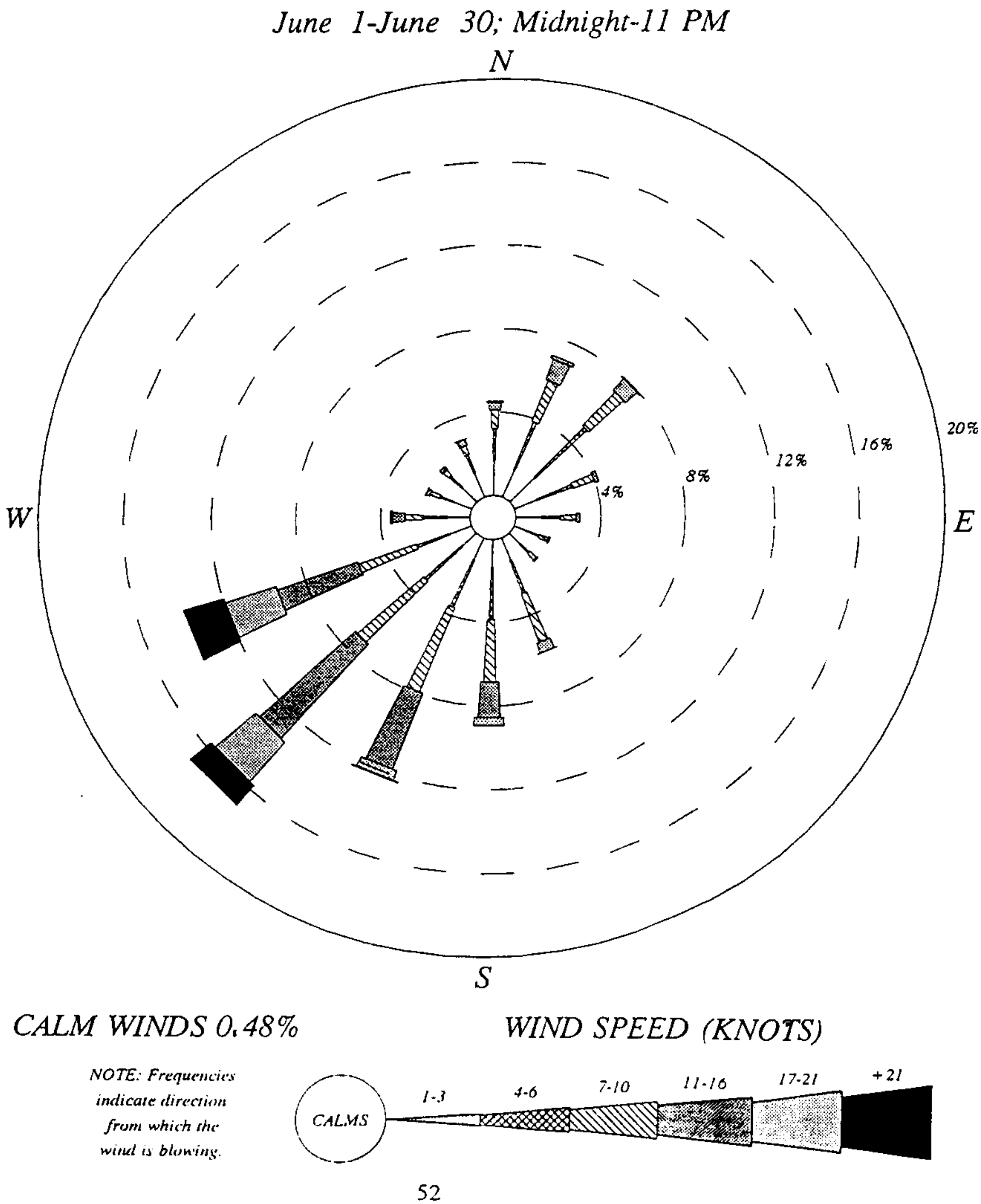


Figure 4-7. Monthly average wind rose for July (1990 to 1994)

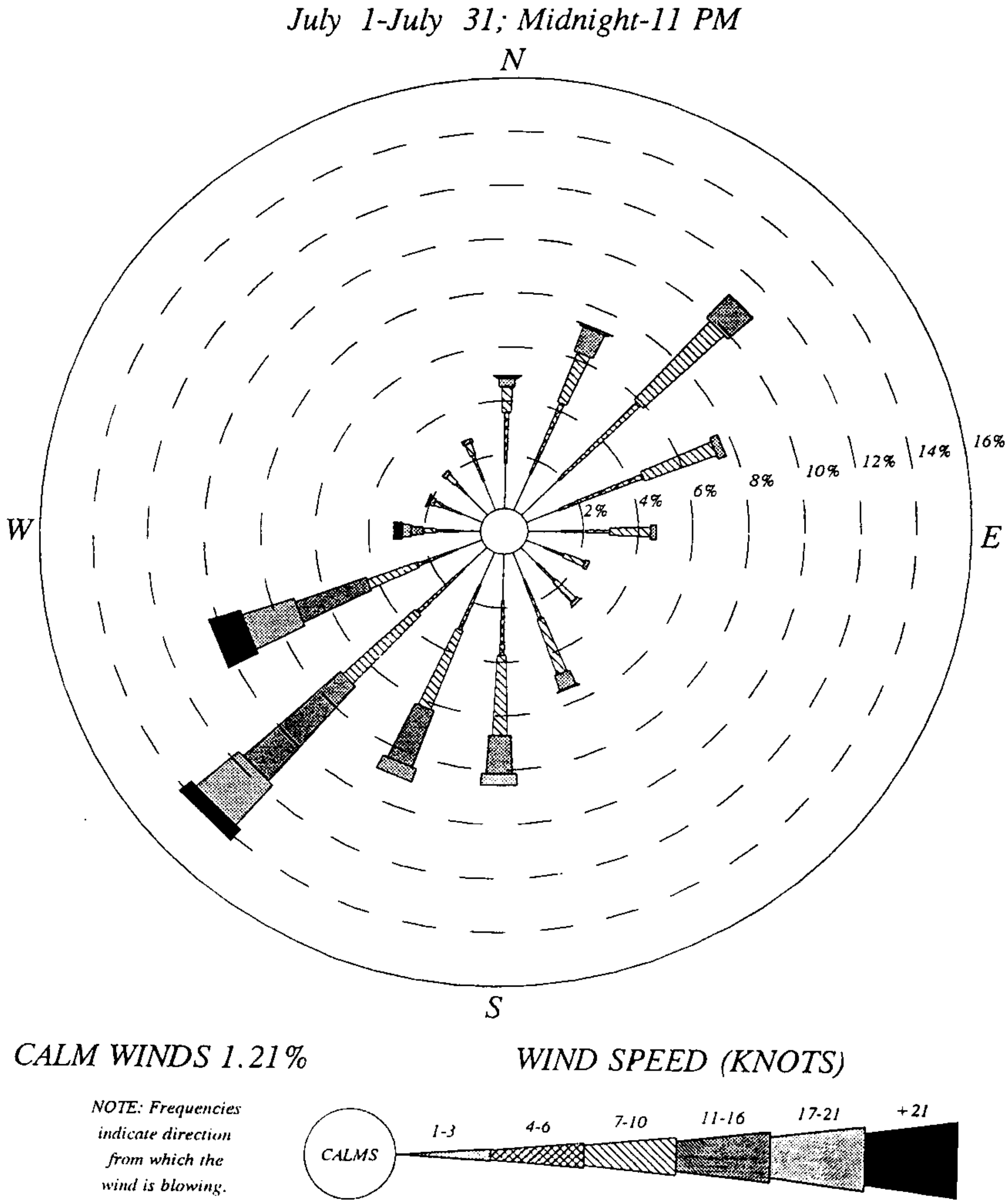


Figure 4-8. Monthly average wind rose for August (1990 to 1994)

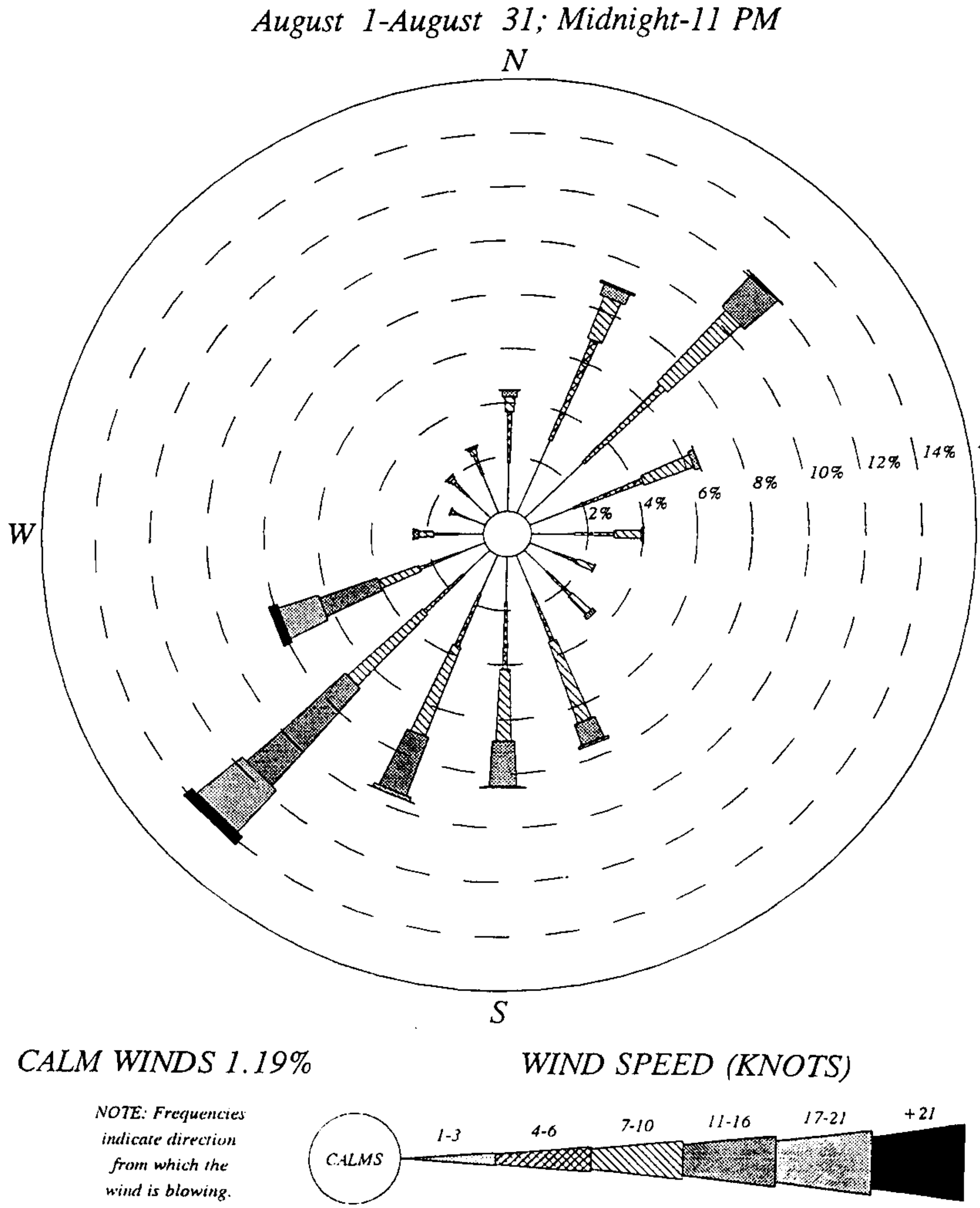


Figure 4-9. Monthly average wind rose for September (1990 to 1994)

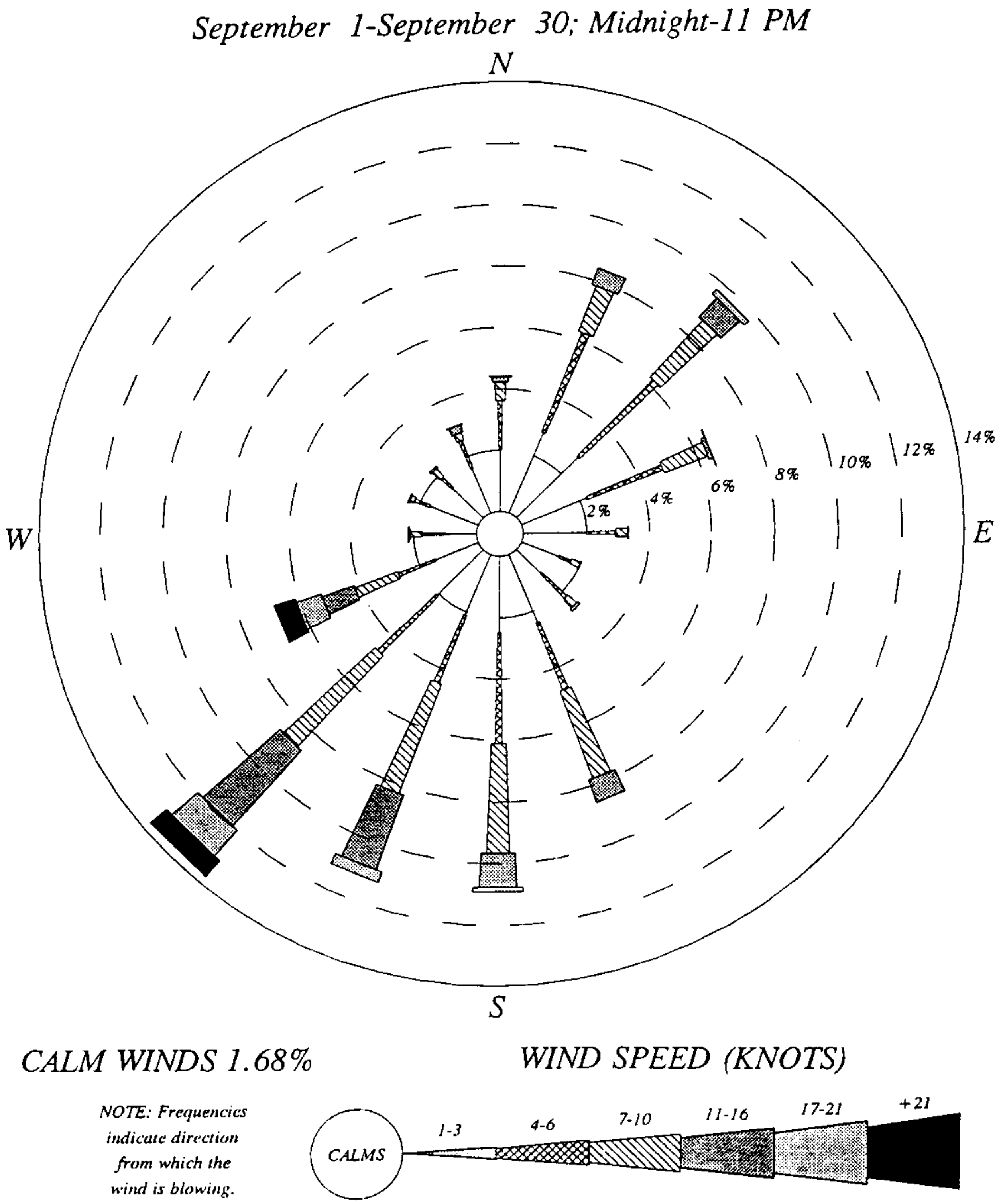


Figure 4-10. Monthly average wind rose for October (1990 to 1994)

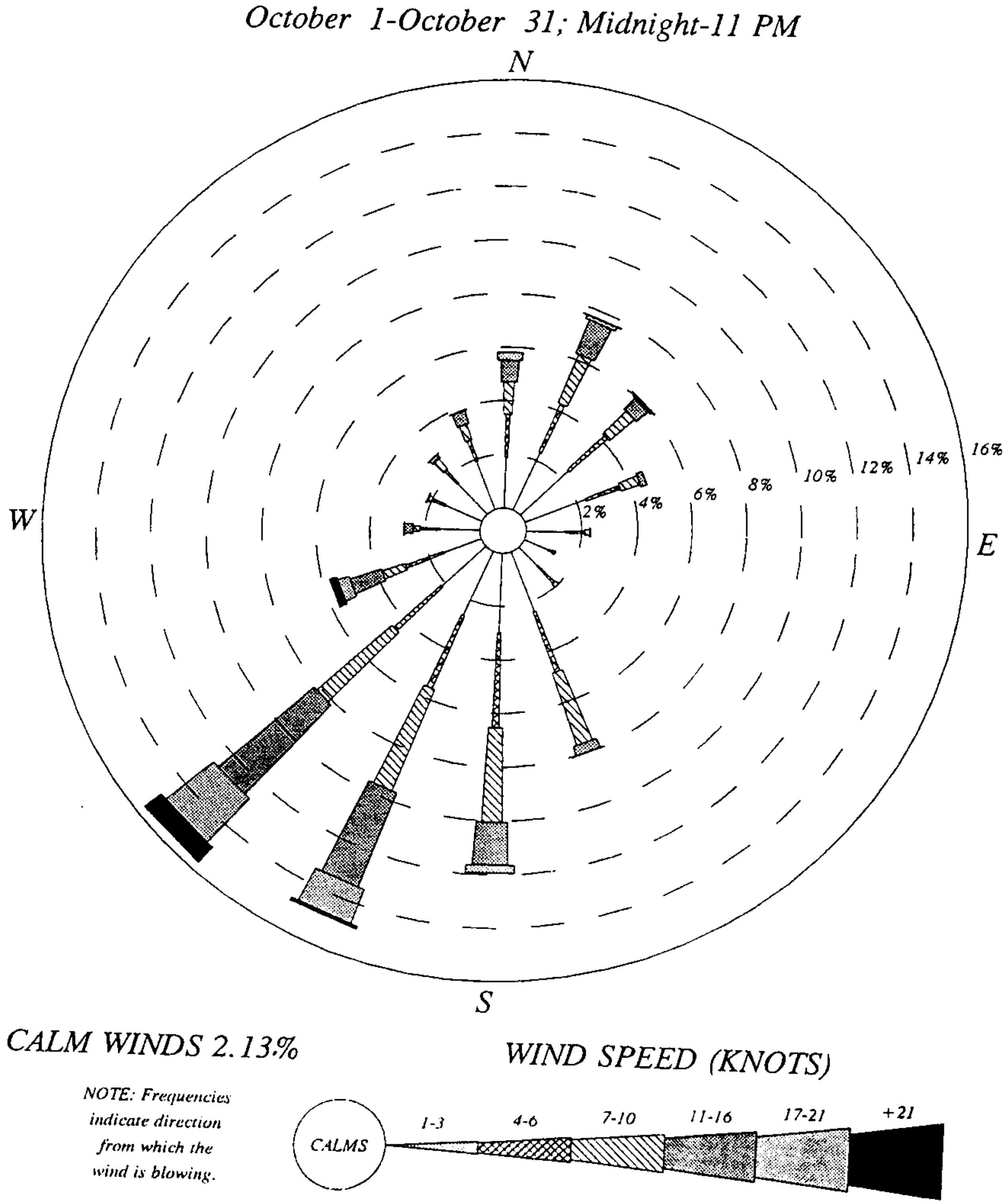


Figure 4-11. Monthly average wind rose for November (1990 to 1994)

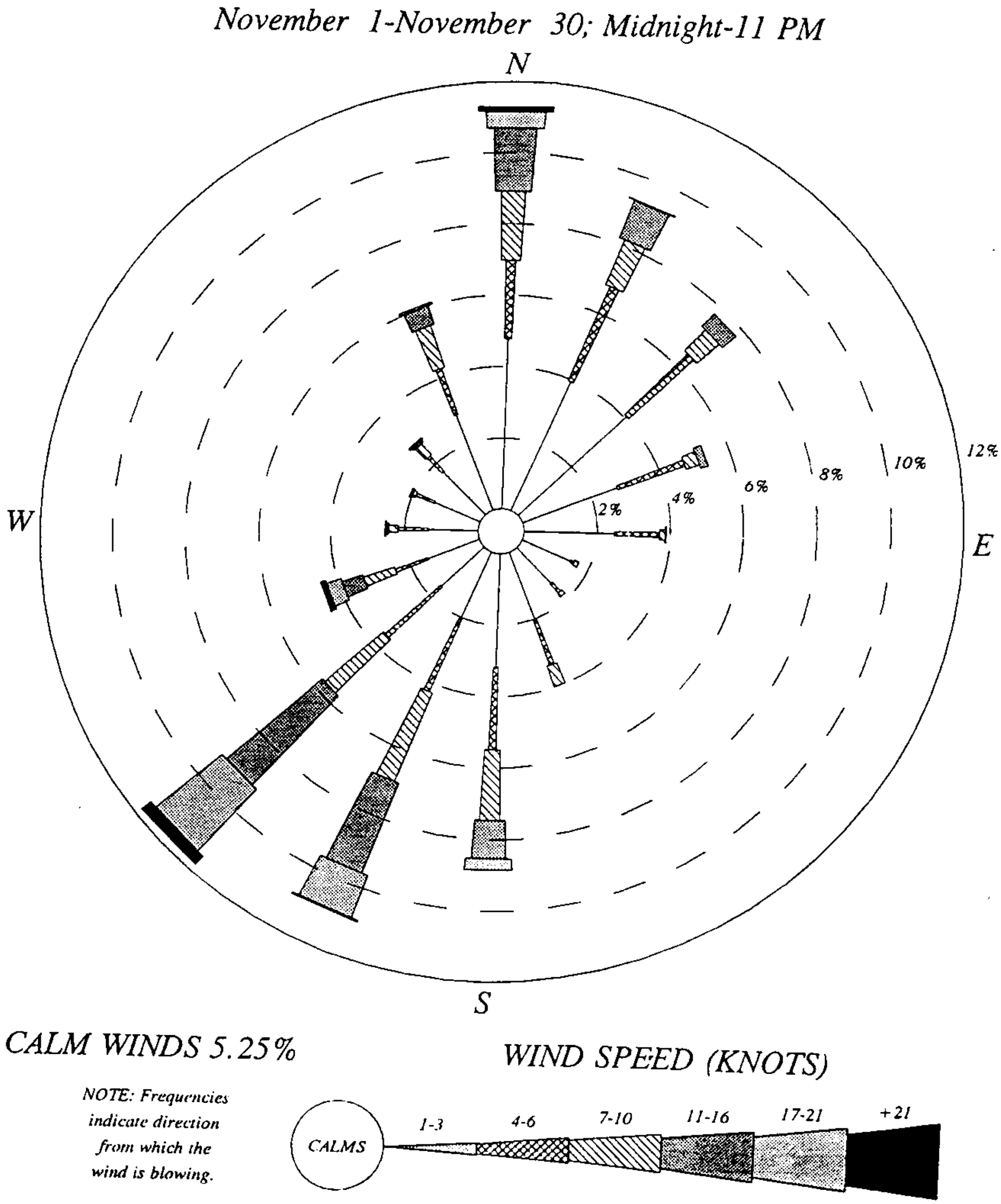
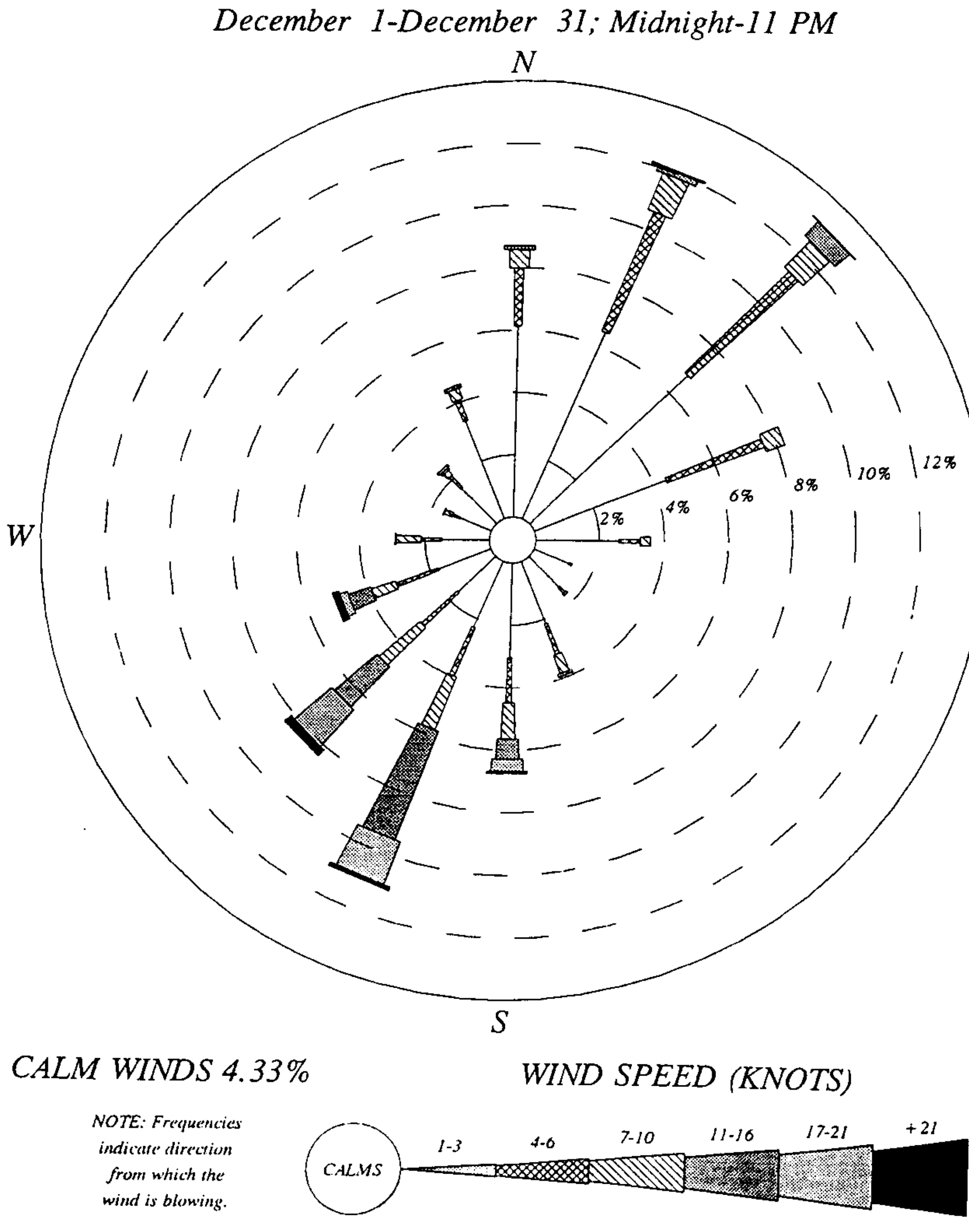


Figure 4-12. Monthly average wind rose for December (1990 to 1994)



4.3.1 Surface Geology

The ANL-W facilities are within a topographically closed basin. Low ridges of basalt found east of the area rise as high as 100 feet above the level of the plain. Surficial sediments cover most of the underlying basalt on the plain, except where pressure ridges form basalt outcrops. Thickness of these surficial sediments ranges from zero to 20 feet (Northern Engineering and Testing, Inc., 1988).

Test borings at ANL-W have revealed two distinct horizons in the surface sediments. The uppermost portion, from zero to several feet below land surface (BLS), consists of a light brown silty loam. The upper one to two feet of this silty loam horizon contains plant roots. The second horizon is a sandy-silt that extends from approximately 2 feet to the underlying basalt. The silt and fine sands (loess) of both horizons were probably transported by wind from other parts of the plain. The windblown loess is calcareous and light buff to brown in color. Small lenses of well-sorted sands that occur within the lower horizon are probably the result of reworking by surface runoff into local depressions. The lower portion of this second horizon generally contains basalt fragments of gravel to boulder size. The upper surface of the underlying basalt is usually weathered, fractured, and highly irregular.

4.3.2 Subsurface Geology

The subsurface lithology presented in this section is based on information gathered from past and recent borings around the ANL-W facility. A core hole to 2000 feet shows the deep geology at ANL-W is dominated by basaltic lava flows. Minor discontinuous sedimentary interbeds occur at various depths, overlying the tops of basalt flows.

The subsurface geology at ANL-W is similar to that on the rest of the INEL as described in section 3.2.3.2. The most striking difference is the lack of thick, continuous sedimentary interbeds beneath the facility. This lack of interbeds can be seen on the lithology diagrams in Appendix A. Those sedimentary interbeds intercepted during drilling appear to be discontinuous "stringers," deposited in low areas on basalt surfaces. These interbeds are generally composed of calcareous silt, sand, or cinders. Rubble layers between individual basalt flows are composed of sand and gravel to boulder sized material. The interbeds range in thickness from less than one inch to 15 feet. Drilling near the Industrial Waste Pond and Main Cooling Tower Blowdown Ditches in 1987 and 1989, targeted a discontinuous, but locally extensive, interbed found approximately 40 to 50 ft BLS, near the waste pond area. This interbed is not continuous across the ANL-W area and does not appear west of the Industrial Waste Pond. Other interbeds have been identified above the regional water table, at approximately 400 ft, 550 ft, and 600 ft BLS (Northern Engineering and Testing, Inc., 1988). The nature of these sedimentary interbeds and rubble zones does not appear to cause perching, but may retard the downward movement of water and produce preferred flow paths.

As found throughout the ESRP, the thickness and texture of individual basalt (lava) flows are quite variable. Individual basalt flows range in thickness from 10 to 100 ft. The upper surfaces of the basalt flows are often irregular and contain many fractures and joints that may be filled with sediment. The existence of rubble zones at variable depth and extent are shown from caliper logs of hole diameters that reveal zones of blocky or loose basalt. Fractures exposed at the surface commonly have silt and clay infilling material. The outer portions of a flow (both top and bottom) are normally highly vesicular. The middle portions of the thicker flows typically have few vesicles and are dominated by vertical fractures formed during cooling.

The variability of basalt thickness and fracturing also plays an important role in well response to changes in the SRPA. This effect is most notable in well responses to barometric pressure changes. Most of the wells at ANL-W act as water table wells with a rapid responses to barometric fluctuations. However, well ANL-MON-A-11 is very slow to respond to barometric changes, often taking many hours to reequilibriate to barometric shifts. Review of the driller's log for this well shows that a thick, apparently massive, basalt rest just above the water table at this location. This thick flow acts as a confining layer and restricts free air exchange near the well bore. Discussions with the INEL field office of USGS suggest this is common on the INEL and that the local area of such affects tends to be on the order of hundreds of feet. Neither the USGS nor ANL-W believes this effect influences the wells' ability to intercept contaminants from the leach pit (OU 9-08). Furthermore, placement of the well away from the immediate down gradient edge of the source area allows for any lateral spreading of contaminants that may occur above this dense basalt before entry into the aquifer.

This sequence of interbedded basalt and sediments continues to well below the regional water table. The regional water table is typically encountered at an elevation of about 4483 feet above mean sea level (AMSL) near the ANL-W facility. A deep corehole was drilled in 1994 in an attempt to find the effective base of the aquifer. This base is defined as a layer below the surface of the SRPA at which the hydraulic conductivities drop by orders of magnitude. The contact of the effective base is characterized by a large sedimentary interbed (up to 100 feet thick) and a marked change in the alteration of the basalts. This contact was encountered at a depth of 1795 feet BLS in the deep corehole at ANL-W. The sedimentary layer was approximately 15 feet thick.

From a groundwater modeling standpoint the clearly fracture controlled flow character of the aquifer appears to impose an insurmountable obstacle to effective modeling. However, discussions with the USGS (Orr, 1996), and numerous papers have suggested that the basalt aquifer can be represented as a porous media to scales as small as 100 feet by 100 feet before rock and fracture heterogeneities overwhelm the system. For the modeling reported in this plan, scales are on the order of thousands to tens of thousands of square feet.

4.3.3 Soils

Soil samples have been collected in and around the ANL-W site to support specific investigations. Most of these investigations involved characterization efforts of the Industrial Waste Pond and ditches.

4.3.3.1 Soil Survey

A formal Soil Conservation Service (SCS) soil survey map is not available for the ANL-W site. A general soil map (Figure 4-13) shows the soil units representative of the predominant soil series as mapped at the INEL. The soils around the ANL-W facility have been mapped as Aecet-Berenicaton-Bondforms. A description of the soil mapping is included in Appendix B.

4.3.3.2 Soil Physical Properties

Physical properties for soils at ANL-W are limited to general information such as cation exchange capacity (CEC), pH, grain size, and acid/base potential. Soils collected in 1989 from two separate areas around ANL-W were analyzed for pH, specific conductance, cation exchange capacity, and acid-base potential form the basis for this data (Chen-Northern, Inc., 1989). Sample STF1-2 is from an undisturbed site east of the ANL-W facility (Figure 4-14). NWC1-2 is east of the industrial waste pond. Samples were collected in 1.5 foot increments to 7.5 feet or the top of basalt, whichever was encountered first. Table 4-2 below, shows the results of those analyses for the upper three feet of soil.

Table 4-2 ANL-W Soil Sample Physical Properties

Sample No.	Depth (ftO	pH (s.u.)	Sp. Cond. (μmhos/cm)	CEC (meg/100 g)	Acid/Base Potential (tons $CaCO_3$/ 1000tons)
STF1-2	0 - 1.5	7.4	4.68	20	97
	1.5 - 3.0	7.5	10.9	16	164
NWC1-2	0 - 1.5	7.4	0.66	36	47
	1.5 - 3.0	7.6	0.68	30	92

(After Chen-Northern 1989)

4.3.3.3 Soil Chemical Properties

As mentioned previously, soil sampling at ANL-W has been conducted to support specific investigations. Soil samples from the above locations were also composited by depth and analyzed for 40 CFR 264, Appendix IX inorganics (Figure 4-14). Table 4-3 shows those results for the 0 - 1.5 and 1.5 - 3.0 foot depths. Also shown in Table 4-3 are average Idaho and National soil values for certain constituents for comparison. Annual soil samples were collected for low level plutonium analysis from the four remote corners of ANL-W through 1994. Results have been consistently in the femtocurie (10^{-15}) range (Table 4-4).

4.3.4 Sediment

As with soils, sediment samples from the Industrial Waste Pond have been collected for specific investigations. The earliest samples were collected in 1986 as part of a study on chromate chemistry in the pond (Villareal, 1986) and were analyzed for pH and certain anions. Sample locations were along the east side of the pond (Figure 4-14). These results are shown in the Table 4-5.

Annual sediment samples were collected from the IWP near the ditch inlet and sampled for RCRA TCLP constituents from 1986 to 1991. No contaminants have ever been detected above regulatory limits. Sediment samples were also collected annually for low level plutonium and gamma-emitter analysis. Levels were consistently in the femtocurie range for all radionuclides analyzed (Table 4-6).

4.4 Hydrogeologic Overview

This hydrologic overview is a compilation of data collected up to 1995. Water samples from previous investigations plus more recent results are presented. Groundwater data from 1993 to the present have been collected under the guidance of the INEL Groundwater Monitoring Plan. Although this document has not been revised since 1993, it still serves as the guide for non-CERCLA monitoring at ANL-W. This WAG specific monitoring plan incorporates recent results and changes from the 1993 INEL plan.

4.4.1 Surface Water

There are no permanent, natural, surface waters near the ANL-W. Drainage ditches and discharge ponds were constructed for ANL-W operations and intermittently collect surface water runoff. Recharge to the SRPA at the ANL-W is limited to precipitation as snow or rain, and seepage from ponds and ditches constructed to dispose of wastewater from facility operations. The ANL-W site is near the axis of the Snake River Plain and therefore is not affected by underflow recharge from the mountains north of the INEL. During rapid snowmelt in the spring, moderate recharge to the aquifer can occur. As noted above, however, high evapotranspiration rates during the summer and early fall prevent significant infiltration from rainfall.

Figure 4-13. General Soil Map of the INEL

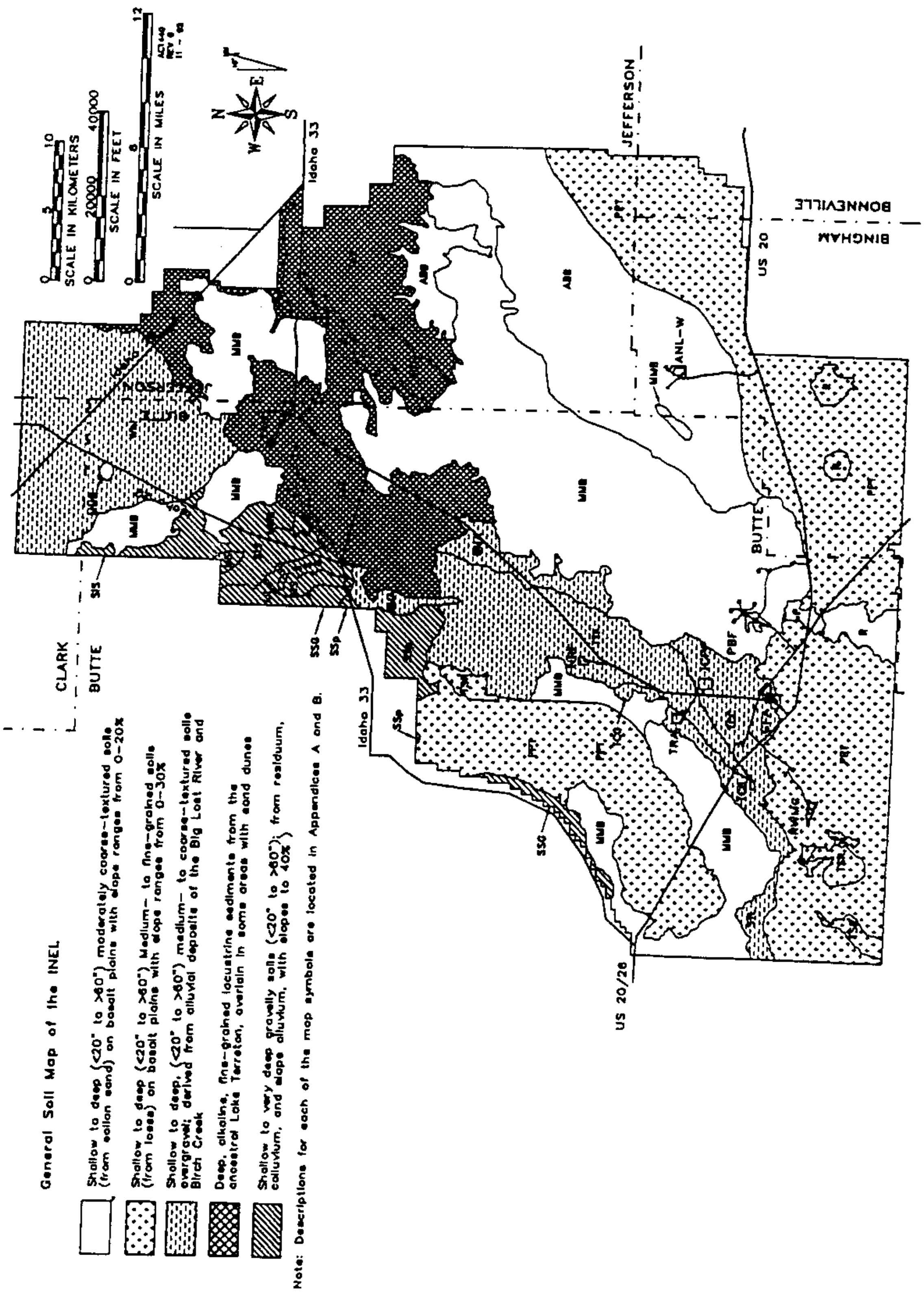


Figure 4-14. Background and Industrial Waste Pond Sampling Locations

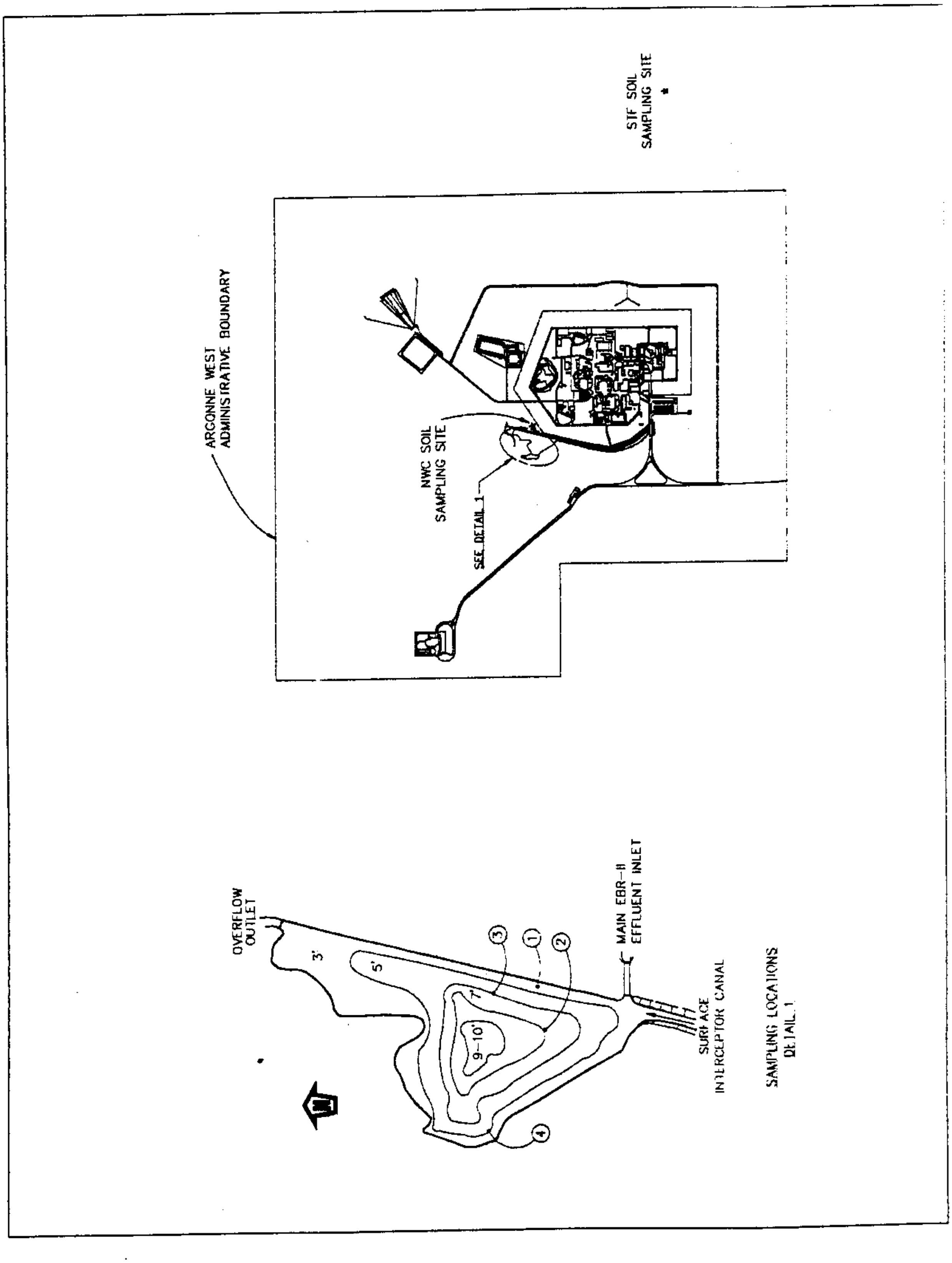


Table 4-3 Results of 1989 Soil Sampling

Parameter	BG-S-1 (0' - 1.5')	BG-S-2 (1.5' - 3.0')	INEL Avg.[A]	Idaho avg.	National Avg.
Aluminum	13,300[a]	13,000	24,000		
Antimony	< 1.1	< 1.1	7.4		
Arsenic	13	16	7.4		
Barium	191	237	440		
Beryllium	3.7	3.6	3.0	< 1.2	6
Cadmium	2.0	2.7	3.7	< 1.2	0.06
Cerium	15,606	77,066			
Chromium	20	22	50	31.4	100
Copper	22	29	32		
Iron	15,900	14,300	35,000		
Lead	14	14	23		10
Mercury	< 0.1	< 0.1	0.074	< 0.1	0.03
Nickel	26	29	55	36.5	40
Potassium	4,630	3,630	6,300		
Selenium	< 0.5	< 0.6	0.32		
Silver	< 0.5	< 0.6	ND		
Sodium	577	1,700	520		
Thallium	< 0.6	< 0.7	0.68		
Vanadium	28	38	70		
Zinc	67	60	220	152	50
Cyanide	< 1.3	< 1.4			
Strontium	49	76			
Phenols	0.4	< 0.1			
Sulfide	< 11.0	< 11.0			

[A] After Rood, et. al., 1995.

Table 4-4 Low-level Plutonium and gamma emitters in soil

Year	Radionuclide 137Cs (pCi/g)	239 Pu (fCi/g)	232 Th (pCi/g)	Year	Radionuclide 137Cs (pCi/g)	239 Pu (fCi/g)	232 Th (pCi/g)
1980				1987			
Southeast	1.9	12		Southeast	0.41	7	0.8
Northeast	0.76	13	NA	Northeast	0.8	20	0.93
Northwest	0.6	20		Northwest	<0.09	<5	0.75
Southwest	1	4		Southwest	<0.09	<4	0.77
1981				1988			
Southeast	0.13	7	1.15	Southeast	1	27	0.97
Northeast	1.15	22	1.44	Northeast	0.62	14	0.91
Northwest	0.34	3	1.15	Northwest	<0.07	<1	0.84
Southwest	0.24	4	0.62	Southwest	<0.05	20	0.93
1982				1989			
Southeast	0.38	13	1.15	Southeast	0.8	< 7	0.93
Northeast	1.47	33	1.31	Northeast			
Northwest	0.1	2	1.29	Northwest	1.03	6	0.87
Southwest	0.12	<2	1.04	Southwest	0.76	< 2	0.88
1983				1990			
Southeast				Southeast	0.08	3	1.3
Northeast		No Data Available		Northeast	0.48	10	1.43
Northwest				Northwest	0.22	7	1.6
Southwest				Southwest	0.11	4	1.39
1984				1991			
Southeast				Southeast	0.04	2	1.4
Northeast		No Data Available		Northeast	0.42	9	1.1
Northwest				Northwest	0.02	<2	1.2
Southwest				Southwest	0.13	5	1.1
1985				1992			
Southeast	1.05	27	1.24	Southeast	0.45	4	0.97
Northeast	1.04	17	1.25	Northeast	0.54	<5	1.13
Northwest	0.13	2	1.14	Northwest		2	0.88
Southwest	0.65	17	1.35	Southwest	0.6	14	1
1986				1993		No Samples Collected	
Southeast	1.5		1.2				
Northeast	2.2		1.4	1994		No Samples Collected	
Northwest	0.58		1.5				
Southwest	<0.15		1.5	1995		No Samples Collected	

Table 4-5 Results of 1989 Sediment Sampling

Sample		pH	SO_4^{-2a}	Cl^-	F^-	NO_3^-	PO_4^{-3}
Upper Sed	(0 - 8 cm)	8.9	51	12	2	2	ND
Lower Sed	(8 -16 cm)	8.9	53	15	2	2	ND
Topsoil		8.4	4	7	2	8	ND

a All units are mg/Kg.
(After Chen-Northern, 1989)

Table 4-6 Low-level Plutonium and gamma emitters in Sediments

	IWP Sediment	
Year	239 Pu (fCi/g)	137 Cs (pCi/g)
1980	<1	1.02
1981	5	0.42
1982	3	0.75
1983	No Data Available	
1984	No Samples Collected	
1985	2	0.13
1986		0.15
1987	<5	0.09
1988	7	< 0.34
1989	1	0.36
1990	< 9	1.14
1991	6	0.06
1992	2	
1993	No Samples Collected	
1994	No Samples Collected	
1995	No Samples Collected	

Seepage from the Industrial Waste Pond and associated conveyance ditches (Figure 1-2) also yields some recharge to the SRPA. The pond has been used since 1964 to receive main and auxiliary cooling tower blowdown water. The discharge rate to the pond varies from 1.42 to 4.22 million gal/month (CH_2M Hill, 1978). Over the period 1961 to 1970, approximately 24 million gal/yr (mgy) was discharged to the Industrial Waste Pond. The average discharge rate is 31.7 mgy, measured over the July 1977 to June 1978 period. The most recent estimate (1979 to 1994) yields an average discharge of 39 mgy. Because of budget reductions and shutdown of the EBR-II reactor, ditch flows in 1995 have not been sufficient to reach the IWP. Recharge of the IWP will occur with the anticipated start up of the Sodium Process Facility in October 1996.

Discharge rates to the Industrial Waste Pond are much lower than discharge rates at other facilities on the INEL (e.g., the ICPP and TRA). The ICPP discharged roughly 1.0 million to 2.0 million gal/day (approximately 370 mgy) to their percolation ponds, over the period 1986 to 1991. TRA discharged an average of 0.5 million to 1.0 million gal/day (approximately 180 mgy) during the same period.

4.4.2 Groundwater

From 1984 to 1986, the ANL-W withdrew an average of 150 mgy from the SRPA. This water comes from two production wells located within the plant. Principal uses of the water are for plant operations, and potable water. Water levels of regional and local wells were measured in 1994 and in 1996. Figures 4-15 and 4-16, present the altitude and general direction of groundwater movement underlying ANL-W derived from the 1996 data. Conditions have not changed since 1994, and show that local conditions follow the general northeast to southwest regional flow. Depth to the SRPA near the ANL-W facility is approximately 640 feet BLS, based on 1996 measurements of water level. The average hydraulic gradient for the regional water table is estimated to be 4 ft/mi. The regional bulk aquifer transmissivity generally ranges from 1.1 to 760,000 ft^2/day (Ackerman, 1991). An average value of transmissivity would be 300,000 ft^2/day. Storage coefficients of the aquifer reflect water table conditions and range from 0.01 to 0.06 (Walton, 1958; Walker, 1960). Tracer studies conducted at the ICPP show flow rates within the aquifer to vary from 5 feet to 20 feet/day, with an average near 10 ft/day (Cooper, 1988). In various studies conducted at the INEL (Barraclough et al., 1967; Robertson et al., 1974) values for effective porosity of the aquifer were seen to range from 5 to 10 percent. On a regional basis, using an average gradient of 4 ft/mi, a mean transmissivity of 93,000 ft^2/day, an average thickness of 250 feet and an effective porosity equal to 5 percent gives an average linear ground water velocity of approximately 6 ft/day. Using these same parameter values gives a hydraulic conductivity equal to 372 ft/day.

Transmissivities of the SRPA near ANL-W range from 29,000 ft^2/day to 556,000 ft^2/day based on aquifer test data from the two production wells at the ANL-W (Martin, and Powell, 1993). The average gradient of the water table near ANL-W is estimated to be approximately 2 feet per mile. Assuming the same effective aquifer thickness of 250 ft, a porosity of 5%, and the above-mentioned transmissivity range, the horizontal groundwater flow velocities may range from 0.9 to 16.8 ft/day. The large spread is due to the skewing effect of well EBR-II no. 1 that is in the upper 6 percent of transmissivity on the INEL. Well EBR-II no. 2 is more toward the norm of transmissivities.

4.4.3 Perched Water

The classical concept of perched water does not apply to ANL-W. In the subsurface basalts at ANL-W, the perched water appears as small, localized zones of saturated conditions above some interbeds and within basalt fractures, rather than as one large perched water body as is seen in the ICPP/TRA area. Perched water as used in the remainder of this section refers to such saturated conditions.

Only three of the six boreholes drilled next to the Industrial Waste Pond encountered free water, and only one of these boreholes yielded enough water for chemical sampling (M5). The three boreholes that encountered free water are found next to the west side of the industrial waste pond (boreholes ANL-M4, -M5, and -M6, in Figure 4-17). Three out of four boreholes drilled next to the Main Cooling Tower Blowdown Ditch encountered free water, but these did not yield enough water for chemical sampling. Video logs of each hole clearly show that the water is being supplied along fractured intervals between 20 feet and the bottom of the hole, and not from a permanent water body. These wells have all been dry since the 1987-88 field seasons. It is believed that the falling level of the IWP has removed the source water from the conductive fractures that supplied these wells.

Water from the Industrial Waste Pond and this shallow free water zone can be differentiated from water derived from the SRPA, in the ANL-W area. Pond water and shallow free vadose water is a mixed cationic (calcium-sodium sulphate) type, whereas ground water from the SRPA is characterized as a single cationic, calcium bicarbonate type (Chen-Northern, Inc., 1988). The similarity in cation percentages between the pond water and the free vadose water samples suggests shallow ground water was derived from downward seepage of pond water.

The localized, non-extensive nature of the shallow water zone is primarily related to two major factors. First is that discharge volume to the ditch and waste pond is small compared with other sites where extensive perched water zones have formed (TRA, ICPP). It is believed that the smaller discharge leads to a lack of sufficient water to form a permanent water body. Secondly, the shallow interbeds are thin and aerially non-extensive compared with other areas where perched water zones exist. This means that not only is less head pressure required to move water through the interbeds but the interbeds may not even exist in locations to retard vertical movement.

Figure 4-15. Groundwater flow in the vicinity of ANL-W.

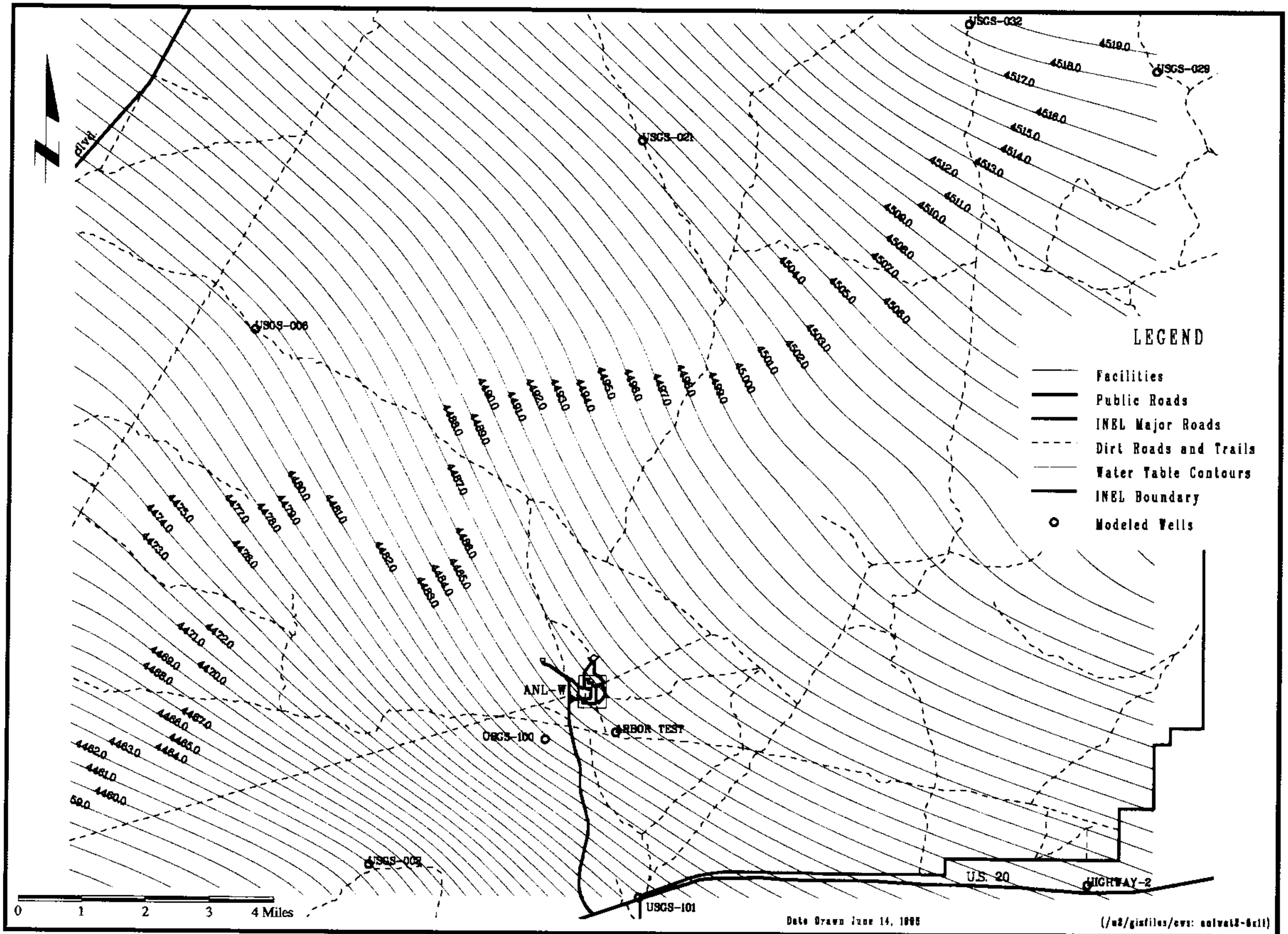


Figure 4-15. 1996 ANL–W Regional Water Table Contours.

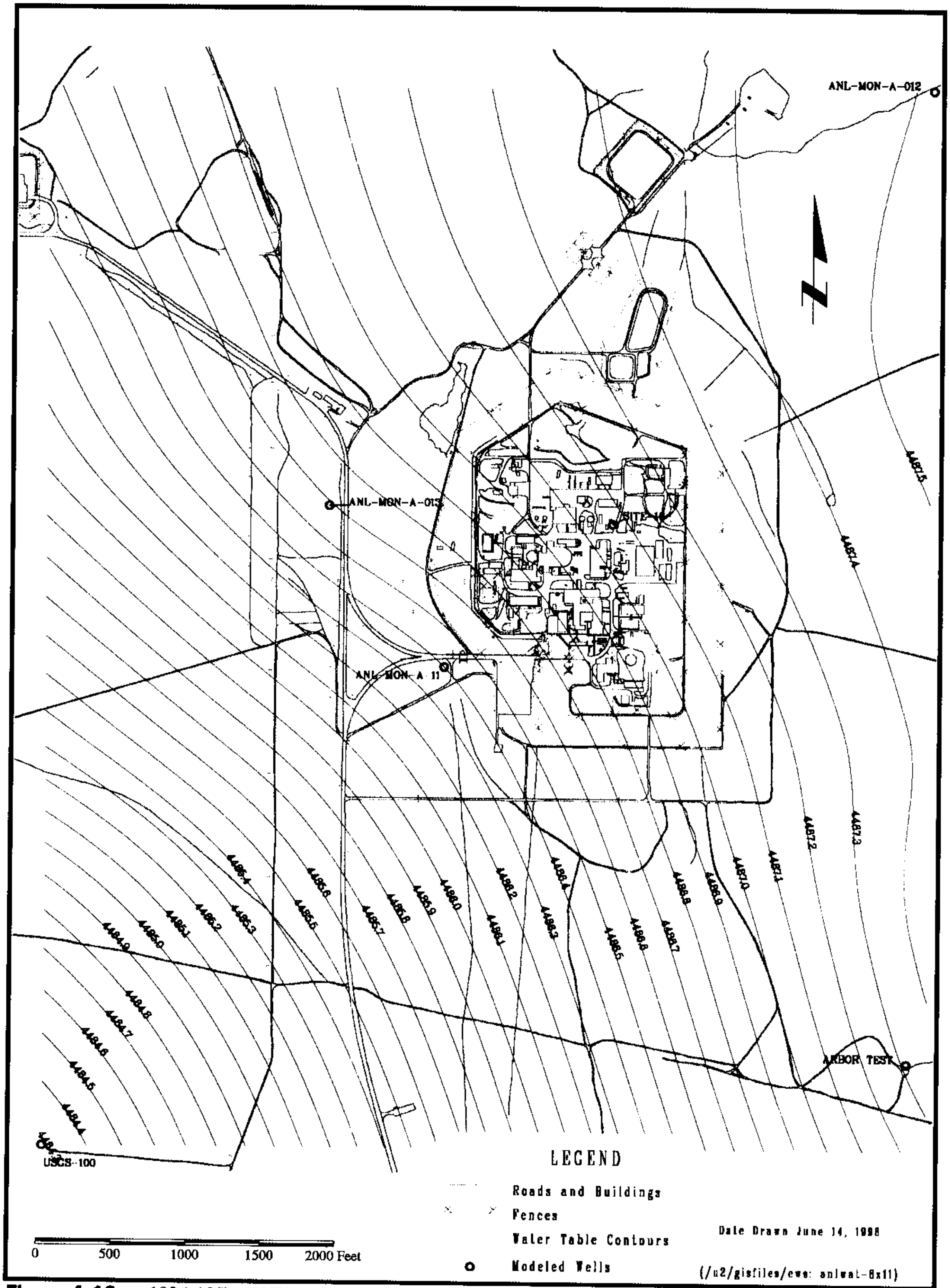
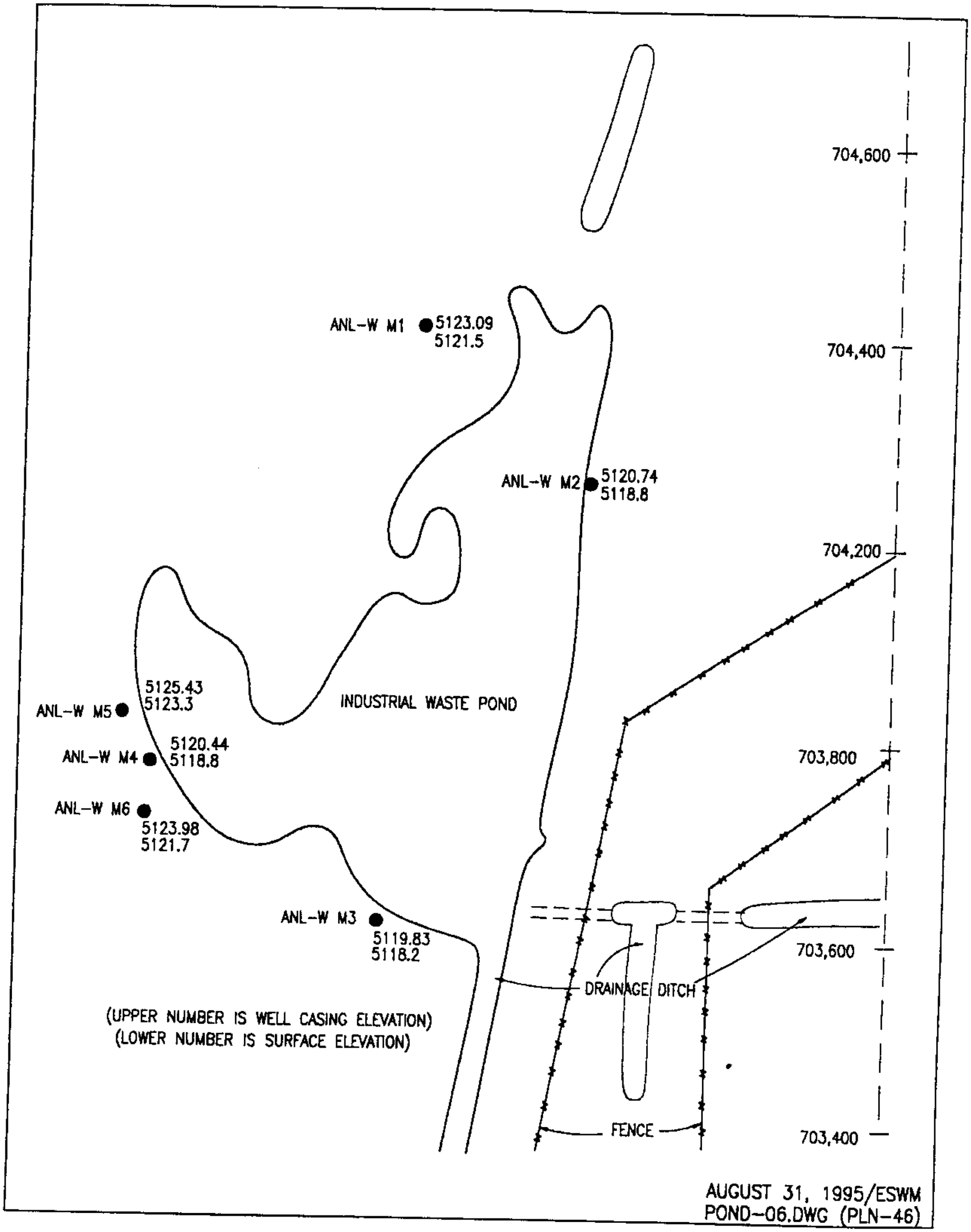


Figure 4-16. 1996 ANL–W Water Table Contours.

Figure 4-16. Local area groundwater flow.

Figure 4-17. Location of ANL-W Industrial Waste Pond Wells.



Other saturated zones may exist, deeper in the subsurface. A fine-grained, sedimentary interbed exists about 400 ft BLS. Neutron logs suggest that this 10-ft thick, unit may be saturated with water. A coarser grained sedimentary unit occurs at a depth of about 550 ft BLS. Neutron logs also suggest that this 10-ft thick unit may retain water (Chen-Northern, 1989a). Neutron logs suggest that an 8-ft thick, very fine-grained sedimentary unit, found about 600 ft BLS, may also be saturated with water. Gamma logs show that the basalt flows underlying the 600-ft sedimentary interbed have a high degree of sedimentary infilling and may contribute to the formation of saturated conditions(Chen-Northern, 1989a).

4.4.4 Background Water Quality

Background water quality data from the SRPA are presented in Table 4-7. The groundwater sample was collected from well EBR-II no.1 (Figure 4-18), in October 1958. The 1958 sampling event was conducted before large-scale operations at ANL-W. In their presentation of the data, Robertson et al. (1974) pointed out the pH, alkalinity, and dissolved iron data are suspect. However, these data provide reasonable background information for evaluating the effects of later INEL or ANL-W operations.

To date one well, ANL-MON-A-12 (M-12), has been installed up gradient of the facility and represents groundwater conditions not influenced by ANL-W operations. This well was to be sampled quarterly in 1994, however, equipment problems allowed only a single sample round to be collected. In 1995 this well was successfully sampled for four quarters for the full list of 40 CFR 264, Appendix IX constituents, and those proposed in the INEL Groundwater Monitoring Plan (Table 4-8). Results from this sampling period are presented in Appendix C.

4.4.5 Current Water Quality

Groundwater samples for the ANL-W area were analyzed for organic and inorganic parameters from 40 CFR 264, Appendix IX, in 1988 and 1989 (Chen-Northern, Inc., 1989). The groundwater samples were collected from three wells at or near ANL-W (EBR-II No.1, EBR-II No.2, and Arbor Test Well) (Figure 4-18).

Organic compounds were detected in these groundwater samples. However, these organics were considered contaminants introduced during field collection or laboratory analysis, since they also appeared in field, trip, or laboratory blanks at equivalent levels. Inorganic parameter analysis of groundwater yielded trace concentrations of As, Ba, Cu, Se, Tl, V, and Zn. The concentrations were within expected values for natural groundwater on the SRPA. The inorganic concentrations for groundwater from this event are listed in Table 4-9.

To date two wells, ANL-MON-A-11 (M-11) and ANL-MON-A-13 (M-13), have been installed down gradient of the facility (See Figure 4-16). Well M-11 is approximately 300 feet down gradient of the Leach Pit (ANL-08) and represents

Table 4-7 Chemical Analysis of Background Water Quality at ANL-W.

CHARACTERISTICS	CONCENTRATION (mg/L, unless noted)
Temperature	54°F
Specific Conductance	293(µmhos/cm @ 25°C)
pH	7.7 (no units)
Total Dissolved Solids	192
Calcium	32
Magnesium	9.7
Sodium	14
Potassium	3.0
Bicarbonate	149
Carbonate	0
Sulfate	13
Chloride	12
Nitrate	1.9
Fluoride	0.7
Silica	33
Dissolved Iron	0.25
Total hardness (as $CaCO_3$)	120

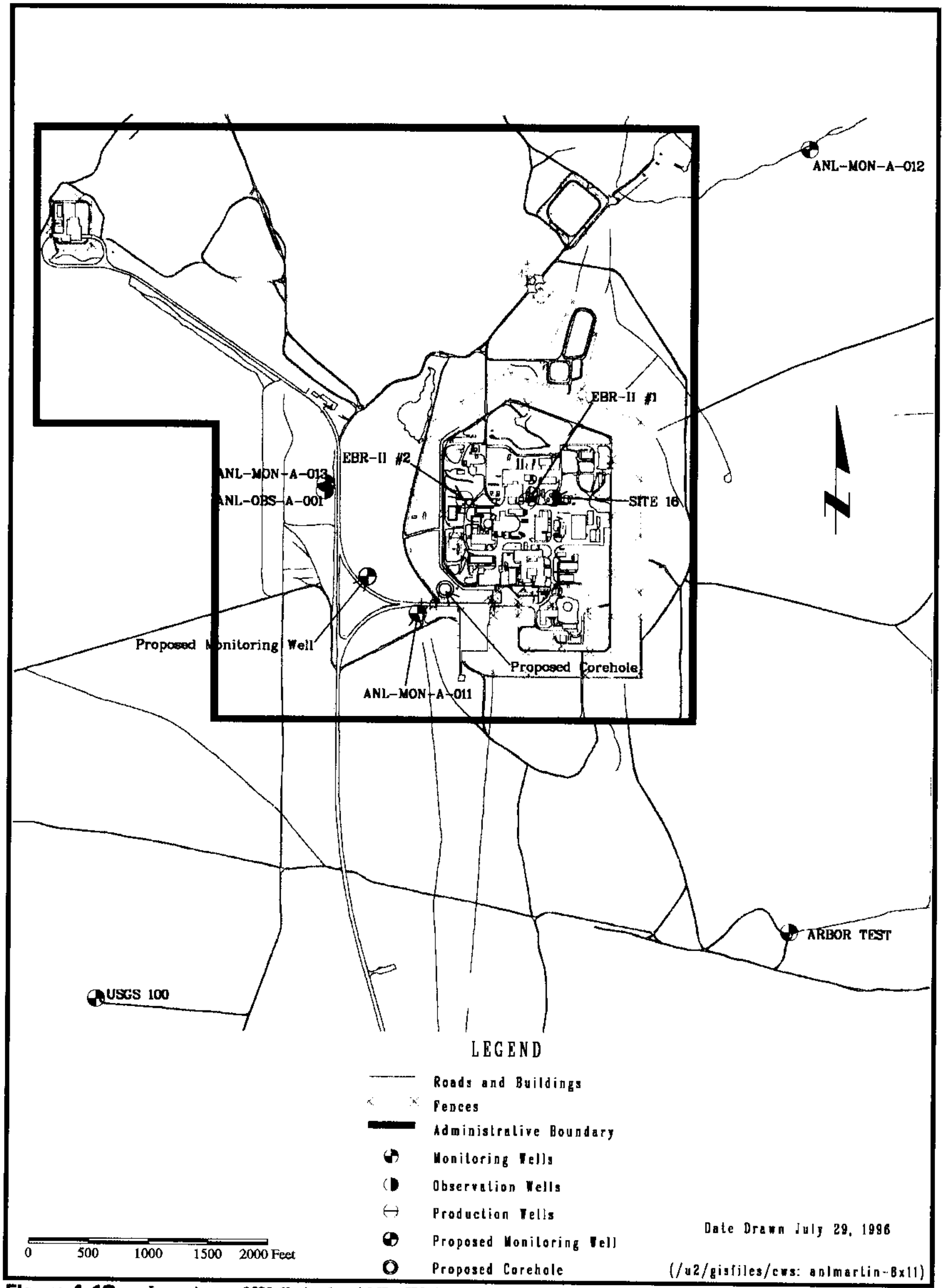


Figure 4-18. Locations of Wells in the ANL–W Area.

Figure 4-18. Location of ANL-W Aquifer Wells.

conditions from that unit. Well M-13 is approximately 1000 feet down gradient of the IWP (ANL-01A). Both these wells have been sampled quarterly (M-11 in 1993 and M-13 in 1995) for the full list of 40 CFR 264, IX constituents and the INEL specific list in Table 4-8. Well M-11 was also sampled twice in 1995. Results of both well sampling events are presented in Appendix C.

Besides the above three sampling rounds ANL-W's two production wells (EBR-II No. 1 and No. 2) were sampled quarterly in 1993 and semiannually in 1995 for the same extensive list as the above. In 1995 the list of constituents analyzed for these two wells and M-11 were reduced to general water quality parameters based on the results of the 1993 sampling. What this amounts to is a substantial cost savings in analysis for compounds that either have not been used at the site or are unlikely to appear in the groundwater. Indicator parameters, for example TOC and TOX for VOC's, SVOC's, and pesticides, are used to show changes in groundwater quality. Results of the EBR-II No. 1 and No. 2 wells are also presented in Appendix C.

Only two organic constituents (Bis-2-(Ethylhexyl) phthalate and Endosulfan II) have been observed above method detection limits. Bis-2-(Ethylhexyl) phthalate is a common laboratory contaminant and is also used as a plasticizer. This compound has been detected in all wells at the site at concentrations from 370 μg/L to an estimated concentration of 29 μg/L. Levels have dropped consistently from May to October 1995. Investigation of sampling records suggests that these detections correlate with the use of a new Teflon sample splitter. The new sample splitter was first used during the May sampling of wells' M-12 and M-13. Thus it follows that the May samples exhibit the highest concentrations. It should be noted that semivolatiles were in the first set of samples collected. Samples from wells M-11 and the EBR-II production wells occurred later that month and show much reduced levels, roughly one-fifth previous levels. The July samples from wells M-12 and M-13 show a continued reduction over the May samples of about one-half. Finally the October samples record estimated values about one third lower than in July.

Estimated detections of the three organochlorine pesticides, Endosulfan I, Endosulfan II, and Dimethoate, have been shown in wells M-12 and M-13. Following industry standard practice the up gradient well (M-12) is always sampled first during any event. Because all three compounds occur at higher levels in the up gradient well than the down gradient one, it is possible that the M-13 concentrations are due to carryover on sampling equipment.

Acetone has been detected at an estimated level of 9μg/L to 12μg/L in samples from wells M-12 and EBR-II No. 2, respectively. Acetone is a common contaminant and often appears in samples. Because levels in the blank samples were at 10μg/L it is believed that these detections are a result of laboratory contamination.

Table 4-8 General and Site Specific Parameters analyzed for at ANL-W as noted in the INEL Groundwater Monitoring Plan.

pH
Total Dissolved Solids
Total Organic Carbon
Total Organic Halides

Gross Alpha
Gross Beta
Tritium

Arsenic
Bicarbonate
Cadmium
Carbonate
Chloride
Chromium
Iodine
Lead
Magnesium
Nitrate
Potassium
Silver
Sodium
Sulfate
Thallium
Zinc
Total alkalinity

1,2 Dichloroethane
1,1 Dichloroethylene
Methylene chloride
Tetrachloroethylene
1,1,2 Trichloroethane
Trichloroethylene

Note: The above parameters are analyzed for in addition to the full list of constituents found in Appendix IX of 40 CFR 264.

Table 4-9 Chemical Analysis of Water Quality at ANL-W.
(After Chen-Northern 1989)

(All values in µg/L)	PW-1[a,h]	PW-2[b,h]	PW-4[c,h]	PW-2D[d,i]	PW-5[e,i]	ATW[f,h]	ATW-b
Methylene Chloride	11 B[j]	6 B	34 B	7 J[j]B	21 B	ND[k]	ND
Acetone	ND	ND	110 B	3 JB	4 JB	ND	ND
Di-n-butylphthalate	3 JB	ND	ND	ND	ND	ND	ND
bis(2-ethylhexyl)phthalate	ND	ND	ND	3 J	ND	ND	8 JB
Chloroform	ND	ND	8	ND	ND	ND	ND
Trichlorofluoromethane	ND	ND	5	ND	ND	ND	ND
2,6-bis(1,1 dimethyl)Phenol	ND	ND	ND	8	ND	ND	ND
N-Nitrosodiphylamine	ND	ND	ND	8 JB	ND	[m]	ND
Di-n-octylphthalate	ND	ND	ND	ND	ND		1 J
Antimony	< 5.0	< 5.0		<30.0		<30.0	
Arsenic	< 3.5	< 3.5		< 2.0		2.4	
Barium	37.0	37.0		33.0		34.0	
Beryllium	< 5.0	< 5.0		< 1.0		< 3.0	
Cadmium	< 5.0	< 5.0		< 5.0		< 5.0	
Chromium	< 10.0	< 10.0		< 10.0		< 10.0	
Cobalt	< 50.0	< 50.0		< 20.0		< 23.0	
Copper	< 20.0	< 20.0		< 10.0		20.0	
Lead	< 2.1	< 2.1		< 3.0		< 5.0	
Mercury	< 0.2	< 0.2		< 0.2		< 0.2	
Nickel	< 24.0	< 24.0		< 20.0		< 19.0	
Selenium	< 2.5	< 2.5		< 3.0		2.4	
Silver	< 2.5	< 2.5		< 5.0		< 2.0	
Thallium	< 3. 0	< 3.0		< 3.0		2.5	
Vanadium	< 20.0	< 20.0		< 10.0		13.0	
Zinc	< 20.0	< 20.0		14.0		437	
Tin	< 114	< 114		< 20.0		< 114	
Phenol	3	< 5		< 5		< 5	

[a] Production Well EBR-II no. 1. (1988)
[b] Production Well EBR-II no. 2. (1988)
[c] Trip Blank.
[d] Duplicate from well EBR-II no. 2.
[e] Trip Blank.
[f] Arbor Test Well.
[g] Trip blank.
[h] Analyzed by Envirodyne Engineers, Inc.
[i] Analyzed by International Technology Corporation (IT).

[j] B - value is above instrument detection limits but below contract required detection limits (CRDL).
[k] J - value is an estimated concentration.
[l] ND - Constituent was not detected (less than CRDL and instrument detection limits)
[m] Blank spaces show constituent was not analyzed for.

A variety of inorganic constituents have been detected over the course of sampling. Only barium, calcium, magnesium, potassium, sodium, vanadium, and zinc are consistently detected above instrument detection levels. Occasional detections above instrument levels of arsenic, chromium, copper, and selenium have also been made. Of all these calcium, magnesium, potassium, and sodium are essentially nontoxic and occur naturally. The arsenic, barium, copper, manganese, selenium, and vanadium are also believed to be naturally occurring since they appear at comparable levels in all wells. Since the detections of chromium are only associated with the older wells (EBR-II no. 1, and no. 2, and M-11), this most likely represents small amounts of leaching of chrome from the stainless steel components of the wells.

The following is a discussion of an evaluation of each well against background levels at ANL-W. Groundwater background concentrations are based on 1958 samples from well EBR-II No. 1, from 1989 samples from wells EBR-II no. 1 and no. 2, and Arbor Test, and from the up gradient well (M-12). Well M-12 itself shows slightly elevated values over those of 1958. Levels of calcium, magnesium, sodium, and potassium are generally 2000 to 6000 μg/L higher. This rise is most likely attributable to lower detection limits and more accurate instruments than those available in 1958. Levels of barium in this well are higher than any other well. They are 10 to 20 μg/L higher than other wells or the 1989 sampling. Levels of other the constituents are comparable to the 1989 results. The elevated zinc levels in this well are attributable to the use of galvanized discharge pipe. It is hoped that at some point in the future at least the portion in the water will be replaced with stainless steel.

Well EBR-II no. 1 shows comparable levels of arsenic, calcium, chromium, selenium and vanadium. Concentrations of barium, potassium, sodium, and zinc are lower, magnesium is slightly higher. The higher iron is a result of the use of perforated carbon steel casing in the well as opposed to stainless steel. Of all constituents analyzed only calcium and potassium are slightly elevated above the 1958 and 1989 levels. All constituents are similar to those found in the other down gradient wells.

Well EBR-II no. 2 shows similar levels of arsenic, calcium, chromium, copper, and vanadium to those from other wells. Concentrations of barium, potassium, sodium, and zinc are lower. Magnesium and calcium are slightly higher than the 1958 level, but are comparable to that in EBR-II no. 1. Potassium is about the same as in the 1958 data. The single detections of chromium, mercury, and those of vanadium are all less than the detection levels of the 1989 data. It is therefore impossible to tell if these are elevated levels. A strong possibility that all three of these constituents are due to laboratory variation exists, since they occur in all wells sampled during the same event.

Well M-11 exhibits comparable levels of arsenic, calcium, chromium, copper, and vanadium to those of the up gradient. Levels of zinc, sodium, and potassium are slightly lower, while magnesium is slightly higher than in the up gradient well. Barium is lower than that in M-12 by approximately 20 μg/L. Calcium, magnesium and sodium are all higher than the 1958 levels, while potassium is about the same. All analyzed constituents are comparable with those from other wells, and to the 1989 levels.

Well M-13 shows levels of arsenic, copper, potassium, and vanadium similar to those of well M-12. Levels of barium are lower than M-12 but comparable to the other wells. Calcium, magnesium, and sodium are all higher than in other wells. This is probably an artifact of the addition of treated water from the IWP up gradient from this well. Calcium, magnesium, potassium, and sodium are all approximately half again as high as in 1958. Barium is at a level about the same as those in 1989, and is similar to the levels in other wells. Most of the other analyzed constituents are levels lower than the 1989 detection limits.

The only radionuclides consistently detected in ANL-W groundwater samples are Americium-241, Neptunium-237, Uranium-234 and Uranium-238. The occurrence of Americium and Neptunium are believed to represent detections of two naturally occurring radionuclides (Radon-222 and Radium-226). This is supported when noting that the activities are virtually identical. The alpha energy of Americium-241 is 5.4857 MeV while that of Radon-222 is 5.4895 MeV, a difference of 0.0038 MeV. Likewise, the associated energies of neptunium and radium are 4.788 MeV and 4.784 MeV, respectively. Further support for this position is that plutonium isotopes have never been detected in any groundwater samples and that the americium and neptunium often occur as a detection of one or the other. For these two radionuclides to be manmade products, since they are related daughter products of plutonium, both would be consistently detected and plutonium isotopes would be found. Further support for this position is given by the fact that the sporadic detections of these two constituents mimic the expected natural decay chain of radium to radon.

The occurrence of the uranium isotopes is to be expected in a mafic basalt terrain such as the Snake River Plain. Of the two isotopes Uranium-234 is the only one consistently detected. An analysis of the respective activities of U-234 and U-238 shows that these two are occurring at levels that would be expected in a natural system.

4.4.6 Perched Water Quality

Only limited information is available on perched water quality. During a 1987 characterization of the IWP three shallow borings (< 20 feet) and three shallow wells (< 400 feet) were installed. Only well M-5 (Fig. 4-16) provided sufficient water for a sample to be collected then. The well was bailed at a rate of approximately 0.5 gpm. Results from this event are listed in Table 4-10. Since the 1987 sampling, other attempts to collect a sample have been made. However, no sample has been collected since the well only occasionally retains a trace (< 6 inches) of water.

Water from the Industrial Waste Pond and this shallow free water zone can be differentiated from water derived from the SRPA, in the ANL-W area. Pond water and shallow free vadose water is a mixed cationic (calcium-sodium sulphate) type, whereas ground water from the SRPA is characterized as a single cationic, calcium bicarbonate type (Chen-Northern, Inc., 1988). The similarity in cation percentages between the pond water and the free vadose water samples suggests shallow ground water was derived from downward seepage of pond water.

Table 4-10 Perched Water Quality Results.

PARAMETER	CONCENTRATION ($\mu g/L$)	MAXIMUM CONTAMINANT LEVEL[a] ($\mu g/L$)
Aluminum	ND[b] (125)	200
Antimony	ND (28)	6
Arsenic	10.1	50
Barium	83	2000
Beryllium	ND (5)	4
Cadmium	ND (5)	5
Calcium	98,600	---
Chromium	ND (10)	100
Cobalt	ND (20)	---
Copper	ND (20)	1000
Iron	75	300
Lead	ND (2.1)	50
Magnesium	30,400	---
Manganese	210	50
Mercury	ND (20)	2
Nickel	ND (24)	100
Potassium	15,000	---
Selenium	ND (2)	50
Silver	ND (2)	100
Sodium	74,300	---
Thallium	ND (2.2)	2
Tin	----	---
Vanadium	ND (20)	---
Zinc	ND (20)	5000
Cyanide	ND (5)	200
Sulfide	ND (1000)	---
Sulfate	----	250,000
Total Organic Carbon	5,100	---
Total Organic Halogens	17	---

[a] Maximum Contaminant Level includes Primary and Secondary MCLs, and MCLGs.

[b] ND - Compound was analyzed for but not detected, number in parentheses is the sample quantitation limit.

5.0 GROUNDWATER MONITORING PROGRAM

The WAG-9 groundwater monitoring program is presented in this section. This program has been developed in anticipation of groundwater monitoring requirements according to the EPA's CERCLA-based requirements as reflected in the INEL FFA/CO.

WAG-9 proposes installation of one additional monitoring well based on the effective coverage of potential release sites as shown in the monitoring efficiency runs in section 5.4.2.2. Installation of this well will be subject to regulator approval of the proposed location, approval by ANL-W management, and distribution of funds from DOE. The groundwater monitoring program will include routine measurement of both general chemical characteristics and water levels from all wells discussed in section 5.4.2.1. The water quality measurements included are designed to detect the presence of hazardous and radioactive contaminants in the SRPA at an established point down gradient from the noted sources. Measurements will be made at both down gradient and up gradient locations. The monitoring program contains the following elements:

- a list of the chemical parameters that will be used to suggest the presence of groundwater contamination,
- the proposed monitoring well network design (number and location of wells, and well construction requirements) for down gradient and up gradient wells,
- the frequency of groundwater monitoring,
- the sampling, and analysis to be used.

The USGS presently conducts groundwater sampling activities at the INEL and near the ANL-W facility. They have carried out this duty since the sites' inception in 1949. Under the charter for the USGS their primary duty is to conduct third party monitoring of INEL facilities. Past results collected by them were used to place the INEL on the CERCLA NPL. The USGS has their own internal quality assurance program. This program meets all the functonal requirements of a CERCLA inverstigation. For this reason, the ANL-W program will be designed to compliment their program and to avoid duplication where possible

The following section describes the groundwater monitoring to be conducted at and around WAG-9, including sampling parameters, monitoring locations, sample frequency, sample analysis, and background monitoring.

5.1 Indicator Parameters

The suite of proposed indicator parameters with recommended methods and detection limits is presented in Table 5-1. These parameters are based upon ANL-W specific

Table 5-1 List of Proposed Monitoring Parameters

Parameter	Method	CRDL (mg/L)
pH	SW[3] 9040/9045	0.5 - 14.0
Specific Conductance	EPA 120.1[1]	N/A
Total Dissolved Solids	EPA 160.1	50.0
Total Organic Carbon	415.2/SW 9060	1.0/1.0
Total Organic Halides	450.1	0.005
Dioxins/Furans	SW 2890	0.01 μg/L
Aluminum		
Antimony	EPA 200.8[1]	0.0004
Arsenic	SW 7060	0.01
Barium	EPA 200.8/200.7	0.002
Beryllium	EPA 200.8	0.0003
Cadmium	EPA 200.7	0.001
Calcium	EPA 200.7 or SW 6010	0.001/5.0
Chromium	EPA 200.7 or SW 6010	0.007/0.01
Cobalt		
Copper		
Iron	EPA 200.7/236.1/236.2 or SW 6010	0.1/0.01
Lead	SW 7421	0.005
Magnesium	SW 6010	5.0
Manganese		
Mercury	EPA 245.1/ .2	0.0002
Nickel	EPA 200.8	0.0005
Potassium	SW 6070	5.0
Selenium	EPA 270.2	0.002
Silver	SW 6010	0.01
Sodium	SW 6010	5.0
Thallium	EPA 200.8 or SW 7841	0.0003
Tin		
Zinc	SW 6010	0.02
Chloride	EPA 300.0[1] or SM[2] 407	0.5
Nitrate	EPA 300.0	0.01
Sulfate	EPA 300.0 or SM 426	0.2
Carbonate	SM 403 (w/alkalinity)	1.0
Bicarbonate	SM 403 (w/alkalinity)	1.0
Total Alkalinity	EPA 510.1	5
Uranium Isotopes		
Gross Alpha	SW 9310	10. pCi/L
Gross Beta	SW 9310	5. pCi/L
Gamma Spectrometry		

1 100, 200 and 300 series methods in "Methods of Chemical Analysis of Water and Wastes," EPA-600/4-79-020, 1979
2 SM = Standard Methods for the Examination of Water and Wastewater
3 SW = SW846, EPA Method 8015; EPA, 1986
4 Prescribed Procedures for the Measurement of Radioactivity in Drinking Water (EPA 600/4-80-032), (EPA, 1982).

contaminants of concern as evaluated in Section 2.2 of the WAG-9 RI Work Plan, past waste water analysis, and three years of water quality monitoring conducted under the guidance INEL Groundwater Monitoring Plan. The proposed parameters have been reduced from the full list of potential contaminants based on a lack of previous detections at ANL-W. Sample parameters have been selected to show any possible change in groundwater quality. They also provide a cost efficient indication of the presence of groundwater contamination without analyzing for an exhaustive list of all contaminants that could be present. If changes in groundwater quality are indicated then additional sampling may be required with a constituent specific list.

Total organic carbon (TOC) and total organic halogen (TOX) analyses will be used as general indicators of the presence of any additional organic compounds. Because most dense, non-aqueous phase liquids (DNAPLs) are pure product organic compounds and would dissociate in water to detectable levels, the lack of detection of organic compounds suggests the lack of DNAPLs at the site. Also, historically DNAPLs have not been used in greater than laboratory quantities at ANL-W. Likewise, gross alpha, gross beta, and gamma spectrometry will be used as indicators to monitor for changes in the concentrations of radionuclides.

5.2 Data Quality Objectives

Data quality objectives (DQOs) are set to establish how much uncertainty that a decision maker will accept for results derived from data collected. Without DQOs, a sampling plan's QA program can document the quality of data obtained, but it cannot ensure that the quality will be sufficient to satisfy program objectives. As noted in Section 5.6 of Data Quality Objectives for Remedial Response Activities: Volume I, Development Process (EPA 1987b), universal goals for analytical precision and accuracy, used in establishing DQOs, cannot be practically established at the beginning of an investigation. However, guidelines are available, through standard reference methods and EPA guidance documents, that will permit uniform evaluation and qualification of reported values. DQOs for this plan will be met in part by proper sampling, reporting, and document control activities, to ensure that accuracy, precision, and representativeness of sample data is of known and acceptable quality. The data quality objectives for this plan are further discussed in the Quality Assurance Project Plan (QAPjP) (Appendix D).

Data collected under this plan will be used to track ANL-W groundwater quality parameters, and to provide support for WAG-9 RI/FS and WAG 10 RI/FS processes. Because of these latter two uses, data will be required to have a high degree of reliability.

5.3 Quality Assurance and Quality Control

The facility specific Quality Assurance Project Plan, included as Appendix D, will be used with all groundwater monitoring. Quality control practices will include analysis of blank, blind, spiked, and duplicate samples. Trip and periodic field and equipment blanks will also be used. All data will be validated to Level A standards.

5.4 Groundwater Monitoring System

This section describes the elements of the groundwater monitoring system and the rationale used to develop that system. It includes a discussion of the groundwater monitoring strategy, and the proposed network of monitoring wells.

5.4.1 Groundwater Monitoring Strategy

A groundwater monitoring strategy was developed that would result in a monitoring network that would be appropriate for the hydrogeologic and source characteristics at ANL-W. The hydrogeologic and source conditions at ANL-W are atypical of most sites on the INEL, and require special consideration in design.

In view of these special hydrogeologic and source conditions, the following strategy has been adopted in designing a groundwater monitoring network for ANL-W:

- Groundwater monitoring wells to be used in the network, will consist of wells to monitor the top of the aquifer for contaminants migrating through the vadose zone,
- Existing groundwater monitoring wells will be used because of their optimal location with respect to the subsurface variability and their construction across the uppermost flow zone,
- Changes to this monitoring scheme will be evaluated after performance of the WAG-9 cumulative risk assessment.

The following hydrogeologic conditions are addressed in the monitoring design for this specific site:

- The top of the SRPA is beneath an approximately 640 feet thick vadose zone consisting primarily of basalt flows,
- Waste water seepage through the vadose zone basalts is most likely fracture-controlled under the flow rate conditions of primary interest here, and difficult to predict in direction and rate,
- Saturated zones may develop beneath larger artificial surface discharge points and can cause infiltrating contaminants to spread laterally beneath their points of origin over distances and in directions that are difficult to predict,
- Saturated zones are ephemeral, lasting months to years after source removal, and consist exclusively of water released from plant operations,

- Groundwater in the SRPA moves laterally in the fractured basalts at the fairly rapid average rate of about 10 ft/day,

- Groundwater movement in the SRPA is largely fracture-controlled, and contaminant migration may occur in directions and at rates that would not be anticipated under normal porous medium flow.

In addition, the following source conditions are addressed in the monitoring design:

- Contaminants would enter the SRPA by migrating through the unsaturated zone and through any intermediate saturated zones that may be encountered, providing an initial distribution over the upper surface of the aquifer,

- Contaminants present as dissolved solutes and organic contaminants are lacking, suggesting that DNAPLs are not be expected to be present,

- All likely potential contamination sources have been identified both within and around ANL-W,

5.4.2 Groundwater Monitoring Network

A groundwater monitoring network that carries out this strategy is developed in this section. ANL-W presently has one up gradient monitoring well located northeast of the facility. One new down gradient well is proposed for installation under this plan. Two existing down gradient wells and one production well will also be included in the monitoring network. The following subsections present the proposed final groundwater monitoring network for WAG-9.

5.4.2.1 Monitoring Wells

A combination of current monitoring and production wells plus one new well will serve as the WAG-9 monitoring network. The existing wells are down gradient of the major source areas of concern (the Industrial Waste Pond, Industrial Waste Ditch, and EBR-II Leach Pit). These wells are shown in Figure 4-18. The proposed monitoring locations provide detection under the southwesterly groundwater flow directions observed at the site. Because of the uncertainties introduced by the thick vadose zone, and the fractured basalts, assuring detection of a release was given greater consideration than when the detection was made (i.e., immediate detection). Consequently the wells are generally about 400 to 1,000 feet from the down stream point of the source areas, to help assure contaminant detection.

The proposed new monitoring well and any additional wells deemed necessary by FFA/CO agencies (EPA, DOE or IDHW) will be designed to monitor the top of the aquifer for contaminants that may migrate through the vadose zone from surface sources. ANL-W will design these wells for optimal monitoring of possible contaminant mobilization from both natural and artificial sources. Downhole geophysical logging will be used to identify the uppermost fracture/rubble zone through which contaminants may migrate. Such zones are potentially important as conduits for contaminant migration. The drilling contractor will screen any such zones found within the upper approximately 50 feet of the aquifer for sample collection. If geophysical logging does not identify a suitable fracture/rubble zone within the upper 50 feet of the aquifer, ANL-W will then make an evaluation of deeper drilling.

5.4.2.1.1 Up Gradient Monitoring ANL-W proposes monitoring groundwater at up gradient well M-12. This well is up gradient of ANL-W approximately 1500 feet northeast of the facility. As shown in the lithologic/well log (Appendix A), this well monitors approximately 30 feet of the aquifer and will provide background data anticipated to be correlatable with sampling results from the proposed monitoring well network.

5.4.2.1.2 Down Gradient Monitoring ANL-W proposes monitoring at the following down gradient groundwater wells; EBR-II No. 2, M-11, and M-13. These wells should sufficiently cover all areas of major hydrologic impact (i.e., the IWP, Leach Pit, and waste ditches). Well coverage for each is as follows:

EBR-II No. 2; approximately 400 feet down gradient of the Industrial Waste Lift Station Discharge Ditch (ANL-35),

Well M-11; approximately 500 feet down gradient of the EBR-II Leach Pit (ANL-08) and the initial discharge to Ditch C of ANL-01,

Well M-13; approximately 1000 feet down gradient of the Industrial Waste Pond (ANL-01).

Besides those wells listed one (1) new well is proposed for installation down gradient of the Main Cooling Tower Blowdown Ditch (ANL-01A). This well would be approximately 900 feet down gradient of this ditch and would monitor the initial discharge to this ditch and a portion of ditch ANL-35.

ANL-W anticipates that this network of wells will detect any future release to the aquifer of WAG-9 contaminants that may presently be in the vadose zone. Based on the known subsurface geology as discussed in Section 4.3.2, ANL-W believes that lateral flow is small. However, the uncertainty associated with fracture flow within the SRPA is taken into account by the proposed well network not being immediately down gradient of the site of concern.

5.4.2.2 Analytical Evaluation of Monitoring Network
The Monitoring Analysis Package (MAP) used for this evaluation was developed by Golder Associates for the DOE and has been used at both the Hanford site in Washington and at the INEL. Golder Associates has included three programs in the MAP program. All analyses done for this plan used MAP version 1.1. Two models are for contaminant plume evaluation and are not used in this evaluation. The third model is called the Monitoring Efficiency Model (MEMO). MEMO operates by generating hypothetical plumes from the defined source area and then determines whether a given network of wells detects those plumes. The model output consists of a shaded map showing the areas at the modeled site where a release would and would not be detected and a calculated monitoring efficiency. MEMO derives monitoring efficiency from the ratio of the size of the area where the model detects a release to the total size of the source area.

It should be noted that model does not report the groundwater flow directions shown in standard compass conventions (i.e., zero is north or up). MEMO reports the flow directions in degrees measured counterclockwise from due east. Using this convention then north is 90°, west is 180°, south is 270°, and east is 0°.

5.4.2.2.1 Geometry of WAG-9 MEMO was used to evaluate the monitoring efficiency of the proposed monitoring network for major potential source areas at WAG-9. These source areas include the EBR-II Leach Pit (ANL-08), Industrial Waste Pond (ANL-01), Main Cooling Tower Blowdown Ditch (ANL-01A) and Industrial Waste Ditches A and C (ANL-01), Industrial Waste Lift Station Discharge Ditch (ANL-35), and the Sewage Lagoons (ANL-04). ANL-W evaluated each source as a separate unit to allow the use of a smaller source and buffer grid.

5.4.2.2.2 Groundwater Flow Direction ANL-W determined the groundwater flow direction from the equipotential map presented in Figure 4-15. The angle of flow is measured in a counterclockwise direction with east being zero degrees. For WAG-9 sites an overall direction of 225 degrees was used. This is consistent with the local/ regional southwest flow direction shown in figures 4-15 and 4-16.

5.4.2.2.3 Source Concentration and Contaminant Detection Limit As outlined above MEMO ascertains efficiency by determining if generated plumes will be detected at a given well location. To do this a minimum plume concentration must be entered. This minimum concentration is based on the ratio of the detection limit of a particular contaminant (C_D) to its concentration at the source (C_0). C_0 may be determined from maximum field values or from regulatory limits (i.e., MCL's). For WAG-9 the conservative constituents nitrate and tritium were used to calculate a C_D/C_0 ratio. Both parameters are known to have been discharged in measurable quantities from ANL-W operations and have established MCL's. Using detection limits of 500 pCi/L for tritium and 0.10 mg/L for nitrate, and their respective MCL's for initial concentrations the C_D/C_0 ratio for these parameters is 0.025 and 0.01, respectively. A value of 0.02 was selected for the present analysis.

5.4.2.2.4 Size of Contaminant Source The contaminant source width is a value assigned for the estimated size of the contaminant source as it impinges on the water table. This value is derived from the surface source width and the anticipated lateral spreading that occurs during travel through the vadose zone. The smaller the width the more conservative the plume dimensions and thus the more conservative the efficiency calculation. For the IWP, Sewage Lagoons, and Leach Pit a very conservative width of 50 feet was used. For the ditches a value of 250 feet was used to account for their long narrow shape. Source widths are measured perpendicular to groundwater flow direction.

5.4.2.2.5 MEMO Data Base Summary The standard data base used in performing the WAG-9 MEMO runs are summarized below.

Parameter	Value
Groundwater flow direction	225°
Dilution contour (C_D/C_0)	0.02
Longitudinal Dispersivity	70 feet
Transverse Dispersivity	20 feet
Line source width	50 feet (250 feet at ditches)
Diffusion coefficient	zero
Decay constant	zero
Contaminant velocity	zero

5.4.2.2.6 Modeling Results Since existing wells were modeled no target efficiency was used. Runs were done to estimate efficiency of the current network. In all cases but the waste ditches (ANL-01 and

ANL-35), efficiencies of greater than 95% were calculated. While the ditch system has a low efficiency (approximately 10%) the initial discharge points of ditch C of ANL-01 and ANL35 are covered. These areas would be anticipated to be the locations of maximum contaminant concentrations. Appendix D includes listing of all input parameters for each MEMO run.

The results of each source run are presented in figures 5-1 through 5-6. Shaded areas on the figures show areas that are not covered by wells. In Figure 5-1 the Sewage Lagoons have been evaluated. The well shown represents well EBR-II No. 2 and is approximately 1200 feet down gradient from the southwest edge of the lagoons. Monitoring efficiency was calculated at 100%. Figure 5-2 shows the EBR-II Leach Pit (ANL-08). The well shown represents well M-11 and is approximately 400 feet down gradient from the southwest edge of the unit. Monitoring efficiency was again calculated at 100%. Figure 5-3 shows the Industrial Waste Pond (ANL-01). The well shown represents well M-13 and is approximately 1200 feet down gradient from the southwest edge of the unit. Monitoring efficiency was again calculated at 97%. Figure 5-4 shows ditches A and C (ANL-01), the Main Cooling Tower Blowdown Ditch (ANL-01A), and the Industrial Waste Lift Station Ditch (ANL-35). The wells shown represent M-11 and M-13. They are approximately 500 feet and 1000 feet, respectively down gradient from the edge of the unit. Monitoring efficiency was calculated at approximately 16%.

5.4.2.2.7 Proposed Well Location Results From the above results only the waste ditches discussed lack sufficient coverage. Runs were made to determine efficiencies with one and two additional wells (Figures 5-5 and 5-6). The addition of a single optimally placed well had a dramatic impact raising the network efficiency by more than 30%. The addition of a second well had only a small effect adding only and additional 15% to the calculated efficiency. This analysis supports ANL-W's position that only one new down gradient well is justified based on cost benefit analysis.

5.5 Groundwater Sampling and Analysis

This section provides information on groundwater sampling and analysis procedures proposed for WAG-9. As noted below, much of the information for this section is incorporated by referencing the Quality Assurance Project Plan in Appendix E.

Figure 5-1. Monitoring efficiency for the Sanitary Sewage Lagoons, ANL-04.

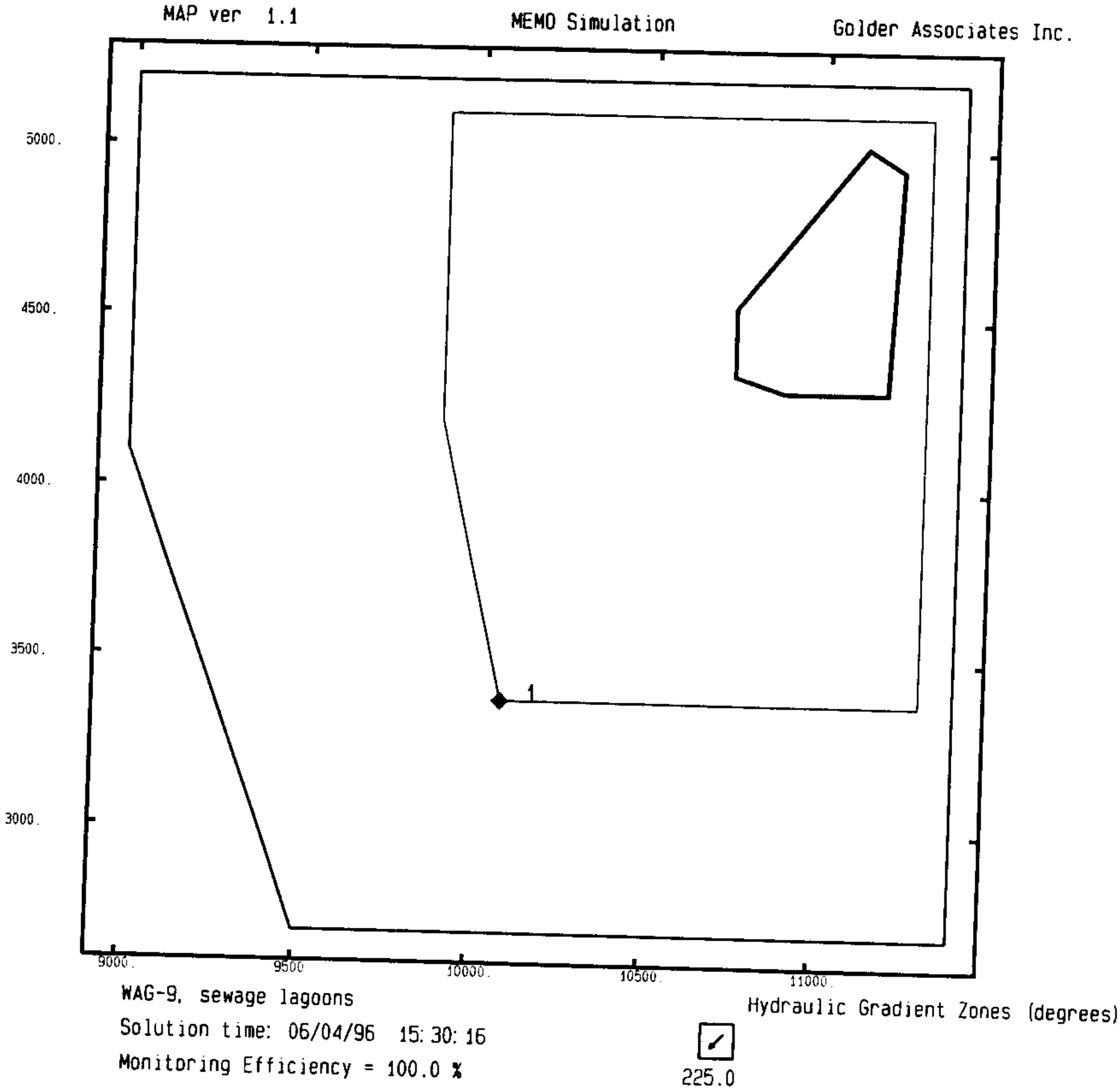


Figure 5-2. Monitoring efficiency for the EBR-II Leach Pit, ANL-08

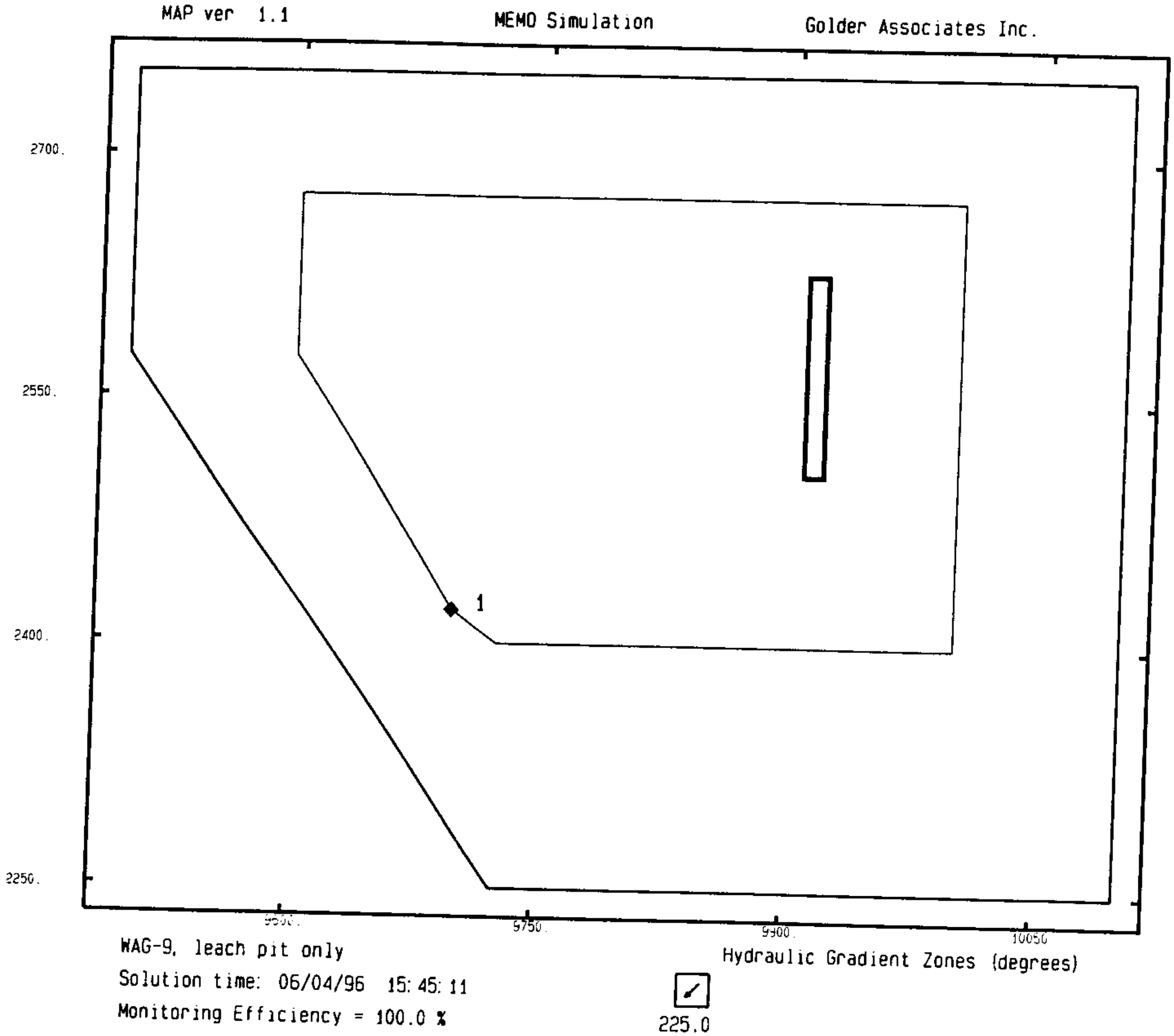


Figure 5-3. Monitoring efficiency for the Industrial Waste Pond, ANL-01.

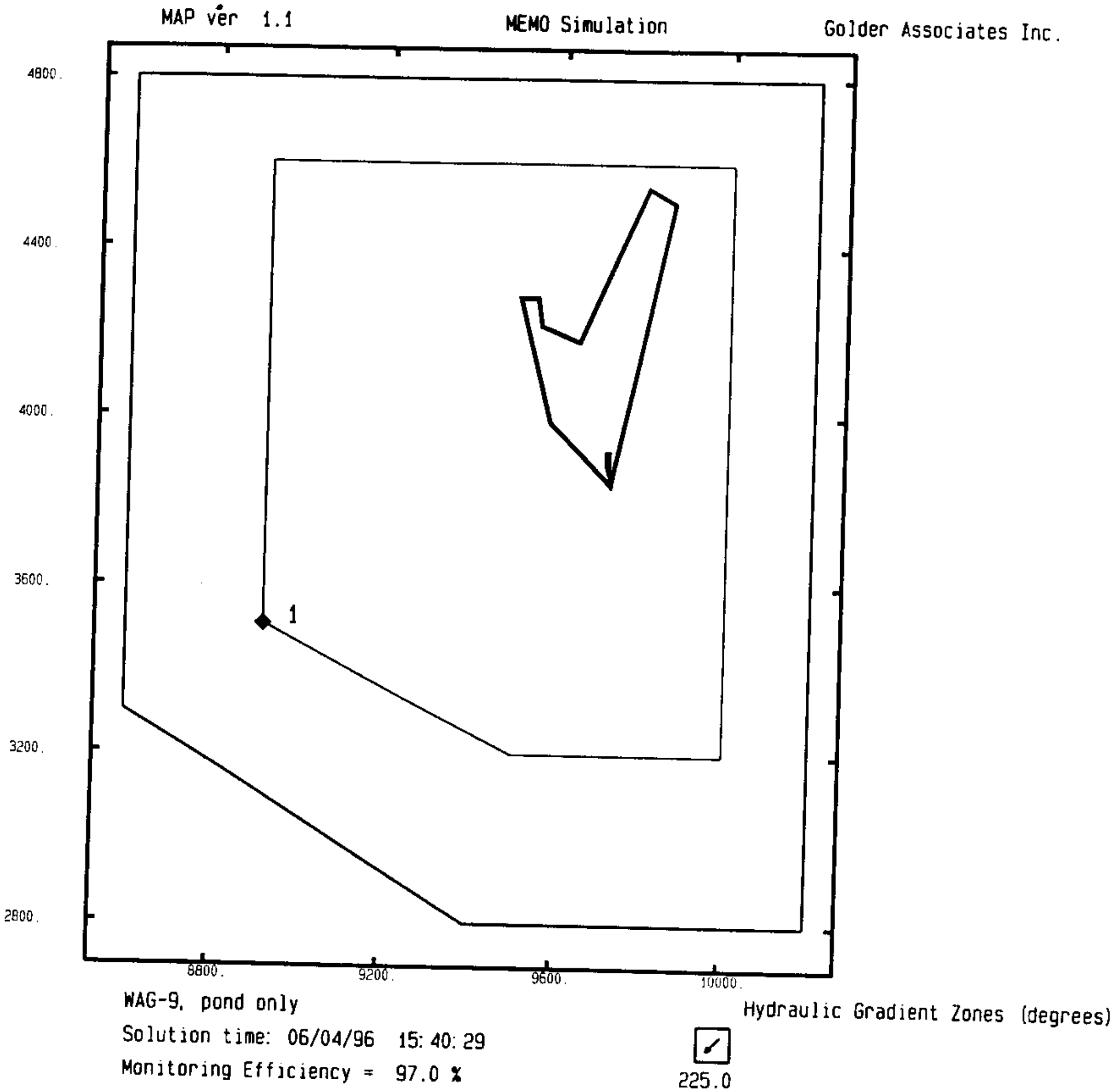


Figure 5-4. Monitoring efficiency for the Industrial Waste Lift Station Discharge Ditch, ANL-35, Main Cooling Tower Discharge Ditch, ANL-01A, and Industrial Waste Ditches A and C, ANL-01.

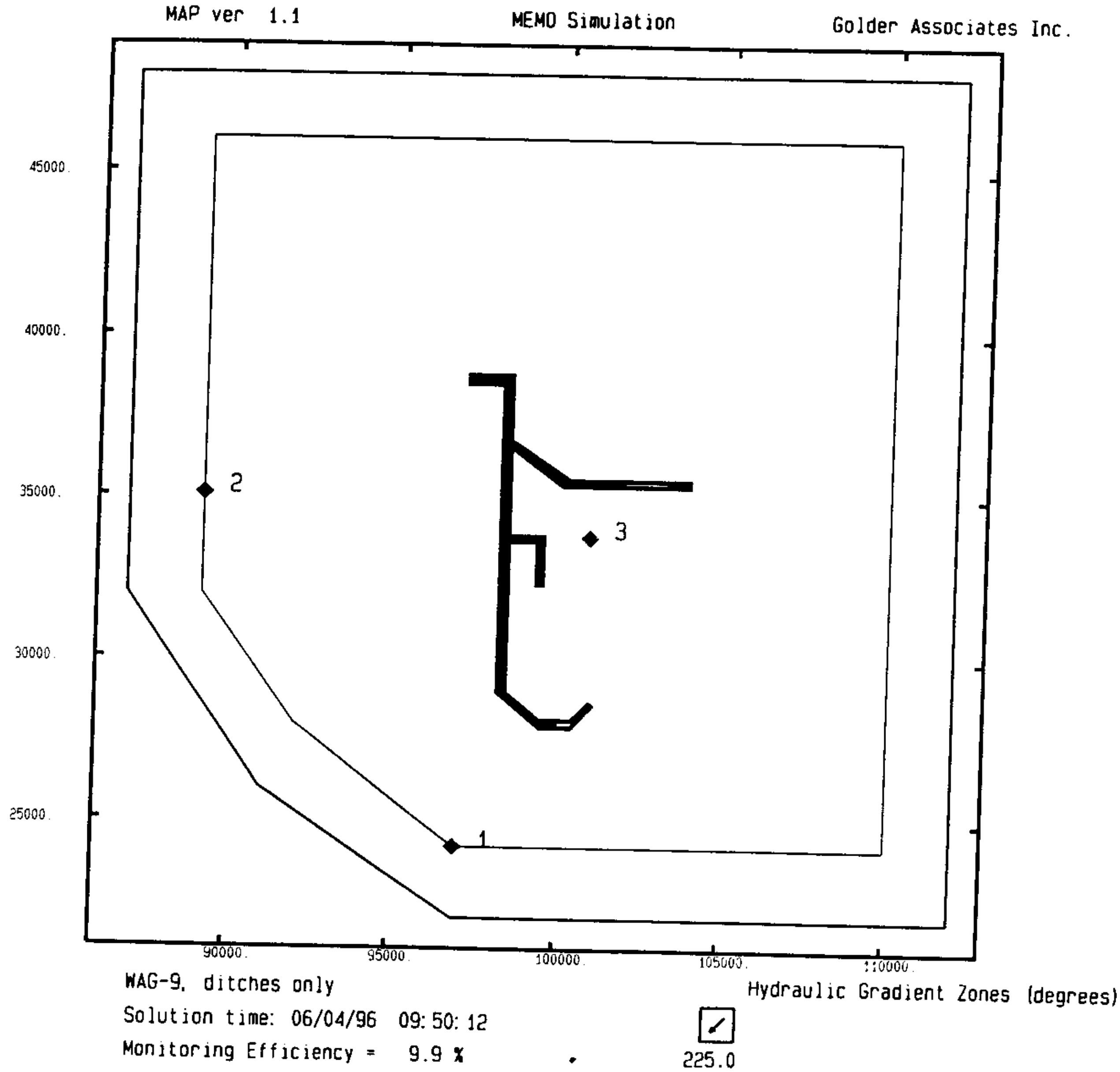


Figure 5-5. Monitoring efficiency for the Industrial Waste Lift Station Discharge Ditch, ANL-35, Main Cooling Tower Discharge Ditch, ANL-01A, and Industrial Waste Ditches A and C, ANL-01, with one new well.

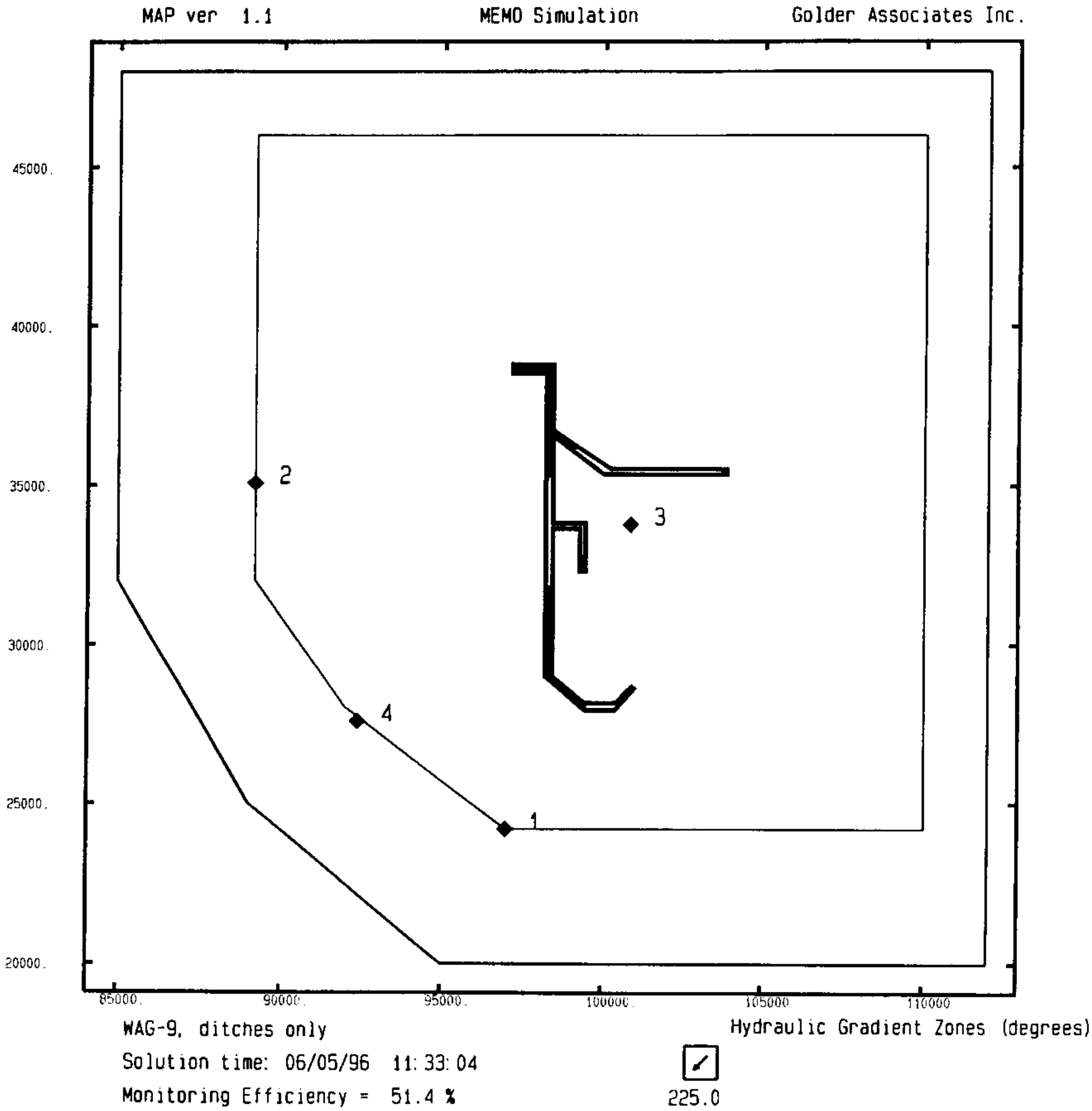
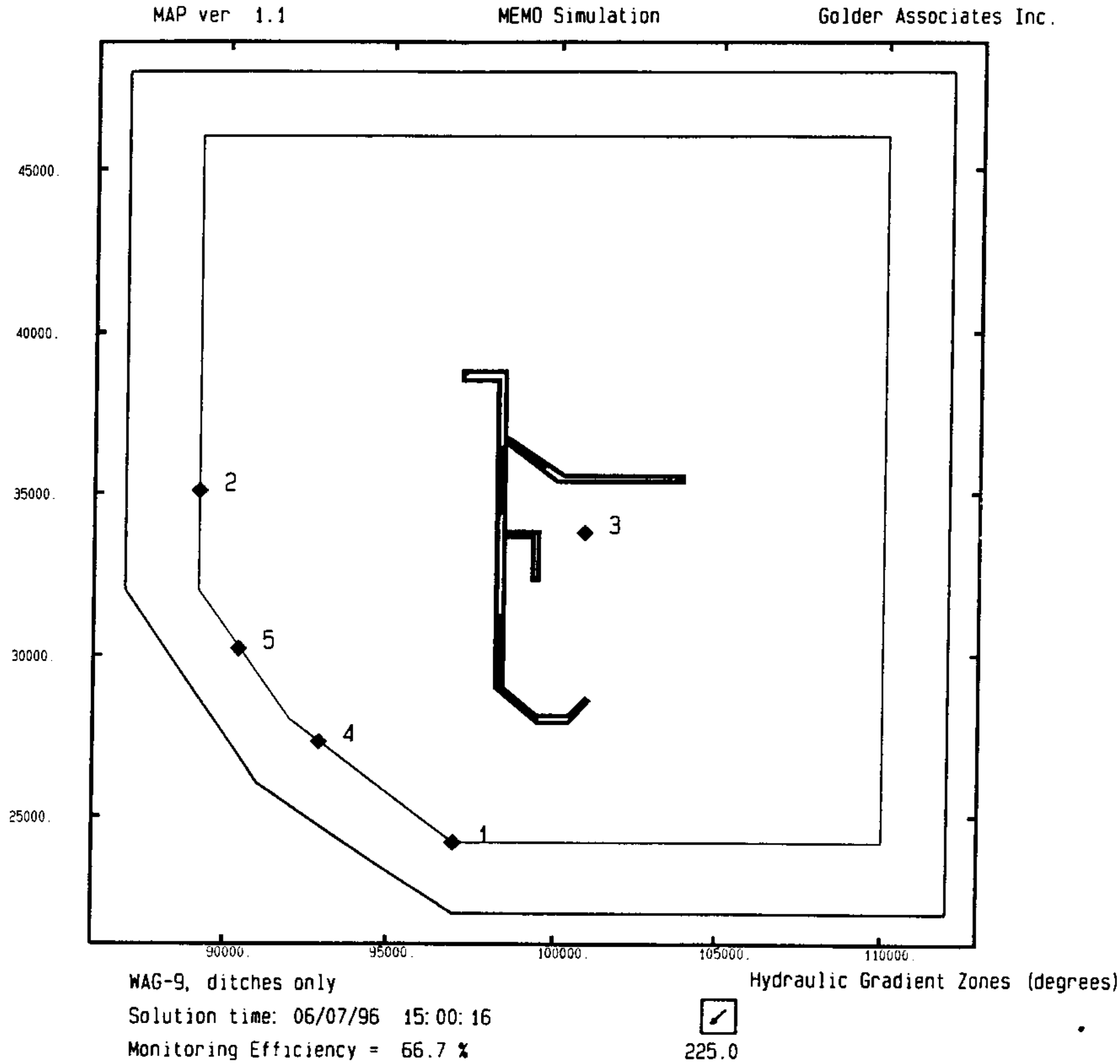


Figure 5-6. Monitoring efficiency for the Industrial Waste Lift Station Discharge Ditch, ANL-35, Main Cooling Tower Discharge Ditch, ANL-01A, and Industrial Waste Ditches A and C, ANL-01, with two new wells.



5.5.1 Sample Collection, Preservation and Shipment

Groundwater samples will be collected, preserved, and shipped following standard industry practices and the Quality Assurance Project Plan (QAPjP, Appendix E). Sample collection will include static water level measurements and well purging before sample collection.

5.5.2 Laboratory Analytical Procedures

All groundwater samples collected under this program will be analyzed at an approved laboratory. The INEL Sample Management Office (SMO) may be used for its capacity to provide preapproved labs. If used, the INEL SMO can provide a collection schedule in tabular form for the requested sampling activity. Analytical procedures and data quality objectives for laboratory analysis of the groundwater samples are specified in the individual labs' master task contract with the SMO. The laboratory performing sample analysis will use standard procedures as recommended by the EPA, and will follow internal, approved quality assurance/quality control procedures.

5.5.3 Chain-of-Custody Procedures

Chain-of-custody procedures will be followed to ensure the integrity of the samples and to trace their possession and handling from the time of collection through laboratory analysis and data reporting. Chain-of-custody procedures are addressed in the QAPjP and in ANL-W procedure AWP-2.1.

5.5.4 Sampling Frequency

Sampling for the full 40 CFR 264, Appendix IX list and indicator parameters began in wells EBR-II No. 2 and M-11 in 1993. Full sampling of wells M-12 and M-13 were completed in 1995. All wells were sampled quarterly in their first year for all parameters listed in Table 4-7 to obtain a statistical baseline. Wells will be sampled semiannually for the duration of the active and postclosure care period of ANL-W. If it is determined that no further risk to human health or the environment is present through the cumulative risk calculations, or that continued sampling provides no further practical purpose, this frequency may be reduced or eliminated at the discretion of, and with a consensus from, the FFA/CO agencies and ANL-W management. As required under CERCLA this decision will be reevaluated in five years.

During each sampling event, an appropriate number of samples will be taken from each monitoring well for all parameters listed in Table 5-1. During subsequent years, new wells and parameters may be added or removed from the sampling program.

5.5.5 Determination of Groundwater Flow Rate and Direction

Groundwater flow rates and directions may be determined annually throughout the period of active groundwater monitoring at ANL-W. Average horizontal flow rates and directions will be determined from groundwater elevation contour maps. If significant changes in the direction of groundwater flow are identified by this evaluation, the continued adequacy of the groundwater monitoring network will be reviewed. If the network is found to be no longer adequate to meet the objectives of this Plan, it will be modified to bring it into compliance.

The velocity of flow will be determined using Darcian flow theory:

$$V = KI/N$$

where:

V = the horizontal groundwater velocity (L/T)
K = the horizontal hydraulic conductivity (L/T)
I = the horizontal hydraulic gradient (L/L)
N = the effective porosity (%).

Present nominal values of the material properties K and N are proposed in the following tabulation, and I is obtained from the groundwater elevation contour maps. Modifications of these values may be proposed as additional knowledge is gained about the groundwater flow system.

Parameter	Value
K	372 ft/day
I	2 ft/mi
N	10%

The direction of flow will be determined from the contour maps from the local direction of the hydraulic gradient.

6.0 STATISTICAL METHODS

The application of statistical methods in the assessment of groundwater compliance allows an objective methodology for controlling Type I and II errors. For the purposes of this document a Type I error is said to occur when it is concluded that a contaminant has been detected when, in fact, it is not present (a false positive). A Type II error is said to occur when it is concluded that a contaminant is absent when, in fact, it is present (a false negative).

The methods discussed in this section are loosely based on RCRA guidance documents published by the EPA. Of most interest are the two EPA documents titled "Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities" published in 1989 and 1992, the 1992 document being an Addendum to the 1989 document. Throughout this section the 1989 EPA document will be referred to as the Interim Final Guidance and the 1992 document will be referred to as the Addendum.

6.1 Introduction

In this section, the methods to be used to decide whether action levels are exceeded (see Section 7) are introduced. In the latter half of the section, a discussion of assumptions and requirements for the application of the statistical methods is given.

6.1.1 General Methods

Assessment of whether action levels defined in Section 7 is exceeded falls into three categories:

- Observed sample concentration exceeds background concentration
- Observed sample concentration exceeds a stated limit
- Projected (trended) concentration exceeds a stated limit.

Three methods are recommended for assessing each of these categories. The first method will be assessed using "prediction intervals"; an upper prediction limit is computed for the background concentrations to decide whether the observed concentration exceeds this limit. The second method employs "tolerance intervals"; an upper tolerance limit is computed on the observed concentrations to decide whether the observed value exceeds the stated limit (e.g., one-half the MCL). The third method employs control charts and regression.

The background concentrations are established through the initial year of sampling at the well, and will be updated periodically. In this sense, "background" is essentially the baseline concentration at a particular well. Background and establishment of background are discussed in Section 6.1.2.1.

6.1.1.1 Prediction Intervals

A prediction interval is constructed to contain the next sample value(s) from a population or distribution with a specified probability. For instance, the routine action level requires comparison of the current concentration to background concentrations. To do this an upper limit of the prediction interval is computed for the background data. The current mean concentration is then compared with this upper limit. If the current mean concentration exceeds the limit, then one may conclude that the current concentration exceeds background.

6.1.1.2 Tolerance Intervals

Tolerance intervals are designed to contain a designated proportion of the population (e.g., 95% of all possible sample measurements). Two coefficients are associated with any tolerance interval. The first is the proportion of the population that the interval is supposed to contain, called the **coverage**. The second is the degree of confidence with which the interval reaches the specified coverage, called the **tolerance**. A tolerance interval with a coverage of 95% and a tolerance coefficient of 95% is constructed to contain, on average, 95% of the distribution with a probability of 95%.

The tolerance intervals will be used to compare current monitoring well data with predefined limits, namely, 50%, 80%, and 100% of the MCL. An upper one-sided tolerance interval is calculated based on the current monitoring data for the well. If this calculated upper limit exceeds the action limit, then it is concluded that the action level has been exceeded.

6.1.1.3 Control Charts and Regression

Control charts are a common tool for characterizing the concentrations in a well over time. Trends and changes in the concentration levels can be seen easily, because all sample data are consecutively plotted on the chart as it is collected, giving the data analyst a historical overview of the pattern of contamination. Consequently, control charts will be kept for each well to help detect whether trends in contaminant concentrations are occurring over time.

The combined Shewhart-CUSUM control chart discussed in the Interim Final Guidance will be constructed for each constituent at each well to provide a tool for detecting both trends (steady increases in concentration) and abrupt changes in concentration levels. Standardized values of the observed mean concentrations from each sampling round are plotted in sequence. If the value exceeds the Shewhart Control Limit (SCL), then an unexpected change in concentration has occurred. The chart will also plot the cumulative sums (CUSUMs) which are sums of deviations from the background mean. When the CUSUM line exceeds the CUSUM Control Limit (h), a trend or abrupt change in concentration has occurred.

If h is exceeded, then regression methods will be done to first determine if there is a trend or if the groundwater concentration has shifted (i.e., a change point). If it is determined that a trend is occurring, the regression line will be used to project the concentration into the future. The projected concentrations will then be compared with the action limit. If the projected concentration exceeds the action limit, then it is concluded that the action level has been exceeded.

6.1.2 Considerations When Applying Statistical Methods

When applying statistical methods to groundwater data, several special considerations and assumptions must be taken into account. Considerations include definition of background and handling "less-than-detectable" (LTD) data. Assumptions used when applying statistical methods include the form of the data distribution, independence of samples, and homogeneity of variances. The special considerations and assumptions used for this Plan are discussed below.

6.1.2.1 Definition of Background The monitoring scenarios discussed in this document differentiate between comparison to background and comparison to up gradient wells, much as is done under the groundwater monitoring requirements in RCRA. Background is established for a well through an initial sampling effort during the first year after installation of the well. That is, the first year of data collected from a well forms the background concentrations for that well.

Monitoring changes in the groundwater from up gradient wells to detect whether any increase in concentration is due to an area up gradient from the monitoring well is also required. The locations of the up gradient wells are given in Sections 5.4.3.

To determine the status of a well with respect to the action levels, background concentrations must be established. Sampling to establish background concentrations is critical to the success of the monitoring. As such, the first year of sampling from a well must be given special consideration, and is discussed further in Section 6.3.

6.1.2.2 Handling of LTD Data The analysis of groundwater data is commonly made more difficult by the presence of LTD data. These are data that represent concentrations below the detection limit of the analytical method. The Interim Final Guidance and Addendum provide several methods for handling LTD data. A summary of their recommendations with respect to the methods advocated in this document follows.

- If less than 15 percent of all samples are nondetect, replace each nondetect by half its detection limit and continue with the analysis

- If the percent of nondetects are between 15 and 50, either use Cohen's adjustment to the sample mean and variance to continue with an analysis, or employ a nonparametric procedure by using the ranks of the observations and by treating all nondetects as tied values

- If the percent of nondetects are between 50 and 90 percent, use the Test of Proportions, discussed in EPA (1989).

When less than 15 percent of the data is nondetect, the use of simple replacement techniques such as one-half the detection limit is acceptable. Using more advanced methods of handling the nondetects will not significantly improve the quality of the data analysis and will have little impact on the results. The detection limit to be used when replacing nondetect values with half the detection limit should be the method detection limit (MDL) for those samples that are not detected. This is discussed in more detail in the Interim Final Guidance and Addendum. However, caution should be used when assigning a value of one half the detection limit, particularly if detection limits change significantly due to sample dilutions. In this situation, the detection limit may be so large as to overwhelm the remainder of the data. Dilution is most commonly a problem when dealing with odd matrices, and therefore should not present a problem for the vast majority of the groundwater sample results. The Interim Final Guidance and Addendum should be consulted for more detailed information.

When the percent of nondetects are between 15 and 50, the EPA recommends the use of Cohen's method. The method involves calculating the mean and variance of the detected data and then adjusting these parameters based on the number of nondetects and the value of the detection limit. The adjusted parameters may then be used in the calculation of the tolerance interval. The adjustment is straightforward to calculate, but requires the use of a table, given as Table 7 in Appendix B of the Interim Final Guidance. The method is good only when less than 50 percent of the data is LTD. The method does not handle multiple detection limits. Cohen's method does assume the data is either normally or lognormally distributed.

When most of the values are nondetect (between 50 and 90 percent), the EPA recommends the use of the Test of Proportions for comparing monitoring well results to background wells. If all the background well results were LTD and all the monitoring well results are detects, one would suspect that contamination has occurred. The Test of Proportions is a more exact method for assessing the same comparison. The method essentially tests whether the proportion of nondetects are much smaller in the monitoring well than in the background wells.

When greater than 90 percent of the values are nondetects, application of statistics will not show anything of use.

6.1.2.3 Distributional Assumptions

The use of statistical intervals such as the prediction and tolerance intervals discussed in this document require that the data follow a particular distribution. Assuming either a normal or lognormal distribution is common. An incorrect assumption about the distribution can seriously influence the Type I and II error rates.

All groundwater data covered under this document will initially be assumed to be lognormally distributed. This assumption will be verified by using either a probability plot or the Shapiro-Wilks test.

If it is concluded that the lognormal assumption is appropriate, tolerance limits will be calculated with the natural log (base e) transformed data. If the assumption is not appropriate, the data will next be checked to find out if it is normally distributed. Failing this assumption, a statistician will be consulted for further guidance in selecting a distribution or nonparametric methods may be applied to the data.

6.1.2.4 Homogeneity of Variance When comparing up gradient concentrations to down gradient concentrations, an initial assessment of the variances from the two groups must be made. The Addendum recommends use of either a boxplot or Levene's test. For the purposes of the monitoring described in this document either of these procedures may be used for assessing the homogeneity of variances, though the Levene's test is preferred.

The boxplot is a simple graphical procedure that requires a subjective assessment about the homogeneity of variances between groups. The Levene's test provides a more sophisticated and objective assessment at the cost of increased complexity.

6.2 Methods for Action Level Assessment

In this section, more details are given for how the methods discussed in Section 6.1.1 are applied to the WAG-9 Groundwater Monitoring Plan. Brief examples are given to illustrate the procedures. Note that the examples are given in untransformed units. In fact, many data analyses will be done on the log-transformed data as discussed in Section 6.1.2.3. General guidance is provided in the Interim Final Guidance and Addendum.

6.2.1 Routine Action Level

The routine action level is invoked when concentrations are at background levels or do not pose a threat to human health or the environment (see Section 7). To establish whether the concentrations are at the routine action level, the following must be assessed:

- If the contaminant is not detected above background concentrations, then it is at the routine action level
- If the measured contaminant concentration is less than or equal to 50% of that parameter's Maximum Concentration Limit (MCL) or risk-based concentration (RBC), whichever is lower, then it is at the routine action level
- If, through trend analysis, the contaminant concentration is not projected to exceed 80% of that parameter's MCL or RBC, then it is at the routine action level.

The assessment of whether a well falls under the Routine action level generally requires three analyses. The first analysis will verify that the analyte does not exceed background for the well and will use a prediction interval procedure. The second analysis will verify that the analyte concentration does not exceed 50% of the MCL and will use a tolerance interval procedure. The third analysis will assess whether a trend is present through a CUSUM procedure, and if so, a verification that the projected trend will not exceed 80% of the MCL.

6.2.1.1 Verification That Background Is Not Exceeded To verify that background is not exceeded, the data analyst will determine the one-sided upper 95% prediction limit on the background concentrations. If this upper limit is greater than the current mean concentration for that analyte, then the action level is Routine. Otherwise, go on to the verification for the Unusual Occurrence (UO) action level.

As an example, consider chloride concentrations in a hypothetical well XYZ. The average background concentration for chloride in this well is 1500 mg/L, with a standard deviation of 300 mg/L. The upper

95% prediction limit (for a mean calculated with 4 current observations and 16 background concentrations) is then 1800 mg/L. The four samples taken during the current sampling period have a mean concentration of 1700 mg/L. Since the upper limit is greater than the current mean chlorine concentration, the well "passes" the first test of the Routine action level.

6.2.1.2 Verification That 50% of the MCL/RBC Is Not Exceeded To verify that 50% of the MCL/RBC is not exceeded, the data analyst will determine the one-sided 95/95% upper tolerance limits on the current observed concentrations. If this upper limit is less than 50% of the RBC for the contaminant, then the action level is Routine. Otherwise, go on to the verification for the UO action level.

As an example, consider barium concentrations in well XYZ. The MCL for this contaminant is 1.0 mg/L; so 50% of the MCL is 0.5 mg/L. The four samples collected during the current sampling period have a mean barium concentration of 0.2 mg/L and a standard deviation of 0.015 mg/L. Then the upper 95/95% tolerance limits on the current barium concentration is 0.277 mg/L. Since the upper tolerance limit is less than 50% of the MCL, the well "passes" the second test of the Routine action level.

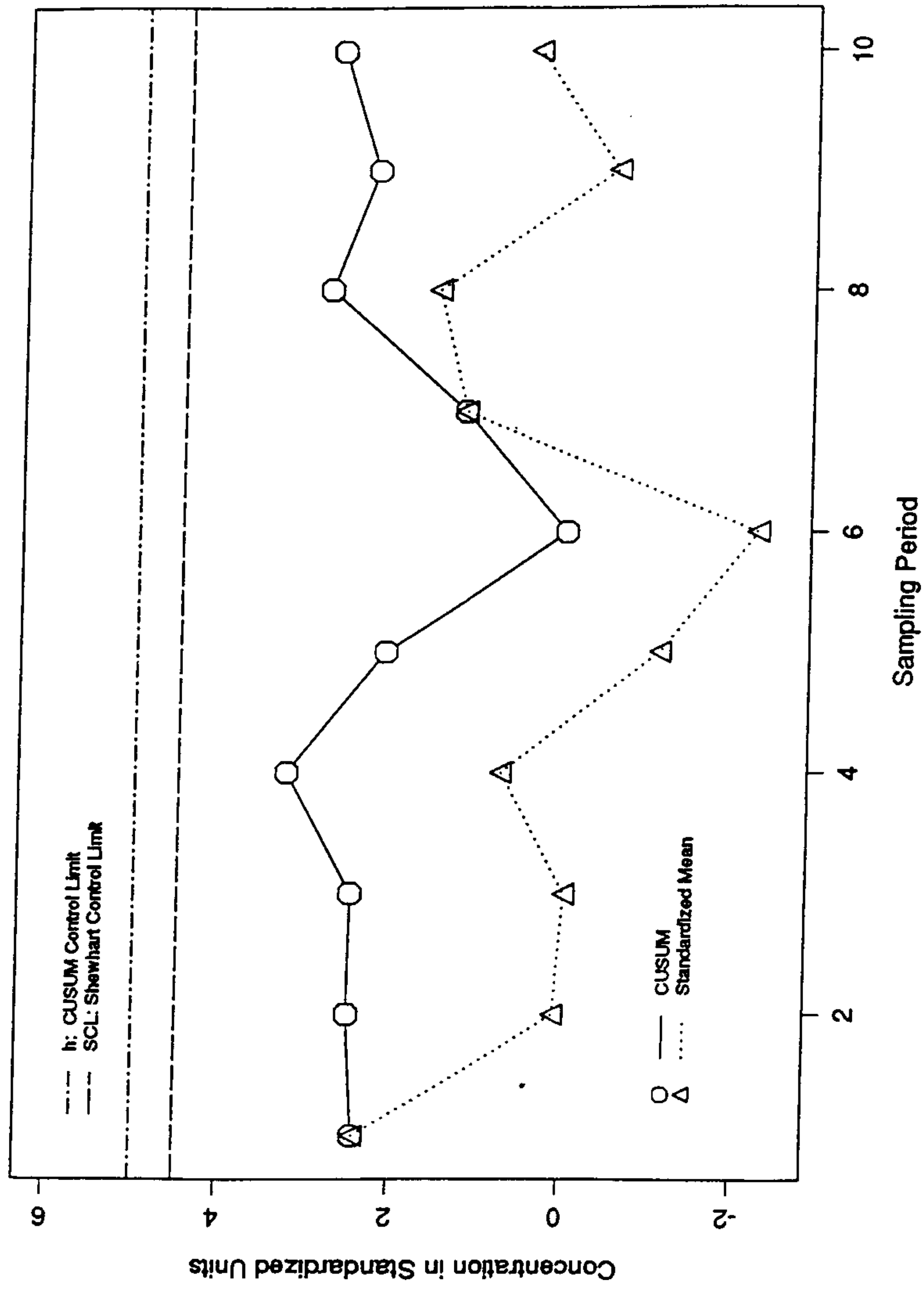
6.2.1.3 Verification That Projected Concentration Does Not Exceed 80% of the MCL/RBC To verify that the projected trend does not exceed 80% of that parameter's MCL/RBC, the analyst must first determine if a trend exists through a Shewhart CUSUM control chart. If a trend does not exist and the analyte has passed the first two tests, then the concentrations are Routine. If a trend does exist, the analyst must do a regression analysis to predict the concentration in the future. If the predicted concentration does not exceed 80% of the parameter's MCL/RBC and the previous two tests were passed, then the concentrations are Routine. Otherwise, go on to verification for the UO action level.

As an example, consider barium concentrations in well XYZ. The control chart for this contaminant is shown in Figure 6-1. Since the CUSUM does not exceed the limit h, there is no need to project the concentrations out and the well "passes" this test. If the other two tests were passed, the well is at the Routine action level.

6.2.2 Unusual Occurrence Action Level

The UO action level includes all analytical results in which a contaminant exceeds background levels. The UO action level is divided into two hierarchical

Figure 6-1. Example of a combined Shewart-CUSUM control chart with h = 5 and SCL = 4.5



responses: Moderate Concern, and Significant Concern responses. Whether the contaminant exceeds background is established through the upper prediction limit discussed in Section 6.2.1.1. To establish the OU response the following must be assessed:

- If the contaminant concentration is greater than 80% of the MCL/RBC or the projected 6-month trend is greater than 80% of the MCL/RBC then it is a Significant Concern response

- If the contaminant is greater than 50% of the MCL/RBC or the projected concentration will exceed 80% of the MCL/RBC within two years, then it is a Moderate Concern

- If neither the first nor second criteria are met, then the contaminant response level is UO.

The assessment of whether a well falls under the UO action level initially requires verification that the contaminant concentration is greater than background. This is discussed in Section 6.2.1.1. If background is exceeded, then determine the response level.

6.2.2.1 Significant Concern Response If the contaminant does exceed background, then the response level must be established. This is done by first determining if the response is a Significant Concern. To establish whether a contaminant is a Significant Concern:

- Determine whether the upper 95/95% tolerance limit of the current concentrations exceeds 80% of the MCL/RBC. If it does, the Significant Concern response is triggered. If not, do the following;

- Check the Shewhart-CUSUM control chart for evidence of a trend. If a trend exists, use regression techniques to predict the contaminant concentration. If, in six months time, this value would exceed 80% of the MCL/RBC, then the Significant Concern response is triggered. If there is no trend or the predicted contamination in six months is less than 80% of the MCL/RBC, then the contaminant is not a Significant Concern and the data analyst will go on to decide if the contaminant is a Moderate Concern.

For example, consider silver concentrations in our hypothetical well XYZ. The MCL for silver is 0.05 mg/L. The upper prediction limit on the background silver mean concentration is 0.01 mg/L, and the current mean concentration and standard deviation are 0.015 and 0.005

mg/L, respectively. Therefore, background is exceeded and the response level within the UO action level must be assessed.

The upper 95/95% tolerance limit on the current concentrations is 0.041 mg/L, which exceeds 0.04 mg/L (80% of the MCL). Therefore the silver concentrations are at least at the Significant Concern level, and should be verified against the Environmental Occurrence action level.

6.2.2.2 Moderate Concern Response If the contaminant exceeds background but is not a Significant Concern, it must next be evaluated against the Moderate Concern criteria. The steps in this evaluation are similar to those for the Significant Concern, only the action levels change:

- Determine whether the upper 95/95% tolerance limit on the current concentrations exceeds 50% of the MCL/RBC. If it does, the Moderate Concern response is triggered. If not, go to Step 2.

- Check the Shewhart-CUSUM control chart for evidence of a trend. If a trend exists, use regression techniques to predict the contaminant concentration in future years. If this value exceeds 80% of the MCL/RBC, then the Moderate Concern response is triggered. If there is no trend or the predicted contamination in future years is less than 80% of the MCL/RBC, then the contaminant is not a Moderate Concern and the data analyst will conclude that the contaminant is at the UO action level.

For example, consider lead concentrations in our hypothetical well XYZ. The MCL for lead is 0.05 mg/L. Say the current lead concentrations exceed background but did not meet the criteria for a Significant Concern. The current mean concentration and standard deviation are 0.01 and 0.002 mg/L, respectively.

The upper 95/95% tolerance limit on the current concentrations is 0.02 mg/L, which is less than 0.025 mg/L (50% of the MCL). So lead passes the first test for the Moderate Concern response.

Next the data analyst plots the current values on the Shewhart-CUSUM chart. Since the CUSUM control limit (h) is exceeded, a trend is present. The analyst next computes a regression equation to predict the concentration at two years from the current date. The predicted value is 0.035 mg/L, which is less than 0.04 mg/L (80% of the MCL). Therefore the analyst concludes that the response level is an UO.

6.2.3 Environmental Occurrence Action Level

The Environmental Occurrence action level is triggered when a contaminant exceeds a Regulatory threshold. This is assessed by calculating the upper 95/95% tolerance limits on current concentrations and comparing this upper limit with the threshold. If the upper limit exceeds the regulatory threshold, then the contaminant is an Environmental Occurrence. Otherwise, it falls into one of the prior action levels discussed above.

As an example of testing whether the Environmental Occurrence action level is exceeded, consider chromium concentrations in our hypothetical well XYZ. The MCL for chromium is 0.05 mg/L. The current mean concentration and standard deviation are 0.035 and 0.002 mg/L, respectively. The upper 95/95% tolerance limit is then 0.045 mg/L, which is less than the MCL. So this contaminant has not triggered the Environmental Occurrence action level. In fact, the analyst would conclude that this contaminant is at the Significant Concern action level as the upper tolerance limit exceeds 80% of the MCL.

As discussed in Section 7, wells that have background concentrations greater than the MCL/RBC can only fall under either the Routine or Environmental Occurrence action levels. So long as the concentrations at the well remains within background (as discussed in Section 6.2.1), the well is in a Routine status. If the well does exceed background, it becomes an Environmental Occurrence.

6.3 Sample Size Assessment

To assess the quality of the groundwater beneath ANL-W properly, a sufficient number of samples must be collected. Without prior data, establishing a statistically appropriate number of samples (sample size) is difficult. Since the potential sources at ANL-W are anticipated to have a small hydrologic impact on the aquifer, and for fiscal considerations, a single independent sample was collected quarterly for each well's first year. Subsequent events will collect a single sample semiannually (once every six months) after the first year.

For wells in which this sampling strategy is adopted, a sampling round is a 6-month interval. All analyses discussed in Section 6.2 are then done semiannually after the first year of sampling. During the first year of sampling, the data should be compared with MCLs and other regulatory thresholds (RBC's) as discussed in Section 6.2. During this time, background concentrations are being established so there is no ability to compare concentrations to background.

If a well has a history of sampling results, then these results will be analyzed to determine the background levels and whether any trends are occurring. These established wells should also be checked to find out the status of the well with respect to the action levels (if not already done). If this evaluation shows that a well does exceed an action level, there may be enough data to confirm the status so that confirmation sampling is not necessary. The current sampling frequencies at established wells will be continued semiannually if they provide sufficient data to meet the data needs for the analyses discussed in Section 6.2.

Once a sufficient amount of data has been collected to establish the characteristics of the groundwater at a specific well, the sampling frequency will be reassessed for that well. For a new well, this will take at least two years of data under the minimum sampling requirements. The reassessment of the sampling frequency will be based on statistical, hydrological, and fiscal concerns.

6.3.1 Independent Samples

The analysis methods discussed in Section 6.2 assume that the individual sample results are independent. The EPA defines independence with respect to hydrogeologic parameters of the groundwater. The intent is to set a sampling frequency that allows sufficient time to pass between sampling events to ensure, to the greatest extent technically feasible, that an independent groundwater sample is taken. The selection of the time between sample collections is discussed in the Interim Final Guidance. The interval is determined after evaluating the uppermost aquifer's effective porosity, hydraulic conductivity, and hydraulic gradient, and the fate and transport characteristics of potential contaminants.

There is some concern that, to assure independence of samples, the samples must be collected with long periods between them, for example, a year between sample intervals. This is due to well specific hydrogeological characteristics. Under this situation, special considerations will be made to meet the needs of the groundwater monitoring program. This will be done on a case-by-case basis. Overall, though, the samples should be evenly spaced over the sampling period. For example, if four samples are to be collected semiannually, then samples should be collected approximately every six weeks.

6.3.2 Routine Sampling

The minimum sampling frequency for routine sampling will generally be one sample semiannually per well. However, after the groundwater parameters for a well are established (a minimum of two years of routine sampling), the sampling frequency will be reevaluated. This evaluation will take into account hydrologic and fiscal considerations, plus statistical requirements.

The statistical reevaluation of sampling frequency should be based on a component of variance analysis, such that the recommended sampling plan will target the largest sources of variation. The recommended sampling plan can provide sufficient data to meet the requirements of the analyses discussed in Section 6.2 on a semiannual basis.

6.3.3 Confirmation Sampling

When a well initially exceeds an action level, a confirmation sample may need to be collected. A single sample should be collected as soon as possible after it has been determined that an action level may have been exceeded. Usually a single confirmation sample should be sufficient. Under certain circumstances, such as a well with large short term sampling variability, collecting more than a single confirmation sample may be desirable.

The results of this sample will be compared with a one-sided 95% lower prediction limit for that well. This limit is to be calculated from the current data that triggered the action level. If the confirmation sample results are less than the lower limit, the action level is considered unconfirmed and sampling and reporting proceeds as before. If the confirmation result is greater than or equal to the lower limit, exceedance of the action level is confirmed and the appropriate response is taken.

The analyst should also compare the results from any well that triggers an action level to those from up gradient wells to see if the source may be isolated. This comparison is best done through Analysis of Variance (ANOVA) techniques. The determination of what wells are up gradient to the well in question will be established at the time of detection.

6.3.4 Nonroutine Sampling

Once an action level is exceeded, the sampling frequency should generally be increased to rebaseline the groundwater parameters in the well. Since triggering of an action level suggests a change over the previous characteristics of the groundwater at the well, the new well characteristics may be established much the same as if the well were new. Therefore, upon exceeding an action level, sampling frequency will be increased to quarterly for one year. Alternatively, a statistical sampling design may be set up based on the historical data from the well and the severity of the problem at the well.

6.3.5 Compounds Found in Blank Samples

Indicator parameters found above detection limits in field or laboratory quality assurance blank samples will be addressed according to EPA guidance (EPA 1989b, p. 6-16). If the parameter is or can be shown to be a common laboratory contaminant, detectable concentrations in well samples will be included in the statistical analysis only if the concentrations in the sample exceed ten times the maximum amount detected in any blank. If the parameter found in the blank sample is not a common laboratory contaminant, the well sample results will be included in the statistical analysis only if the concentrations in the samples exceed five times the maximum amount detected in any blank.

6.4 Results

All monitoring results will be reported annually to the WAG managers. Reported data will include a list of groundwater parameters analyzed, detection limits for each parameter, validated laboratory results, and the results of the data analyses performed. Detailed reporting requirements are identified in Section 7.0.

7.0 CONTAMINATION DETECTION AND RESPONSE

7.1 Introduction

To reduce the potential impact of releases to the environment, and meet the requirements of the applicable environmental regulations, it is imperative that any groundwater monitoring program adopts a consistent and integrated approach toward responding to the detection of groundwater contamination. The purpose of this section is to establish requirements for responding to the detection of any new contamination discovered during groundwater monitoring at ANL-W.

This section establishes action levels (i.e., a pre-specified set of levels of contamination that, when observed, initiate a pre-specified set of responses). The purpose of developing these action levels is to establish consistent response scenarios throughout the program when certain prescribed levels of contamination are observed. The required responses apply to all groundwater monitoring activities at ANL-W (i.e., both observational and compliance monitoring). Any exceptions to adherence to these standards should be documented, with the reasons specified, and forwarded to DOE-ARG.

Three general hierarchical action levels have been established: Routine (no action), Unusual Occurrence, and Environmental Occurrence. Each succeeding action level is associated with a correspondingly higher level of contamination. Depending on the specific action level triggered, both the level and immediacy of response may vary. It should be noted that these action levels (and associated responses) only apply when the detected contaminant has <u>not</u> been previously detected at the observed action level. Therefore, the additional reporting and corrective action responses are not required for known contaminant plumes, unless the level of contamination in those plumes increases to the extent that it exceeds a higher action level.

The thresholds and reporting associated with each action level have three sources: DOE Orders, EPA Regulations and Programs, and INEL-specific best management practices. Two regulatory driven subsets of compliance monitoring activities are RCRA and CERCLA. These regulatory programs have their own response requirements that must be satisfied beyond the INEL-specific requirements. Additional action levels originating from RCRA and CERCLA requirements are discussed.

General responsibility for WAG-9 groundwater monitoring activities resides with DOE-ARG. When specified action levels are exceeded, responsibility may be elevated within the DOE management chain.

DOE-ARG is responsible for:

- Compiling and evaluating all sampling organization reports to decide if any new site-wide groundwater problems exist (based on a comparison between groundwater data and the action levels discussed in Section 7.3)

- Integrating all ANL-W groundwater sampling data and evaluating it, on a site-wide basis, for significant levels of groundwater contaminants or increasing contaminant trends

- Initiating proper responses and corrective actions, when necessary.

7.2 Sample Analysis and Validation

All contractor laboratory analysis of samples will be done according to statements of work (SOWs) issued to approved laboratories. If the INEL SMO is used, procedures for obtaining laboratory services from them are contained in EG&G ERP Policy Directives (PDs) 5.5 and 5.6.

All groundwater monitoring data will be validated to Level A. Data validation is defined as a systematic process for reviewing a body of data against a set of criteria to provide assurance that the data are adequate for their intended use. Method validation is defined as the process of evaluating the accuracy and completeness of analytical data, to a specified level of detail, using a pre-specified set of information or data. All groundwater monitoring data, unless specified otherwise, will be method-validated according to standard practices. Such procedures may include SOP No. SMO-SOP-12.1.1, "Levels of Method Validation," SMO-SOP-12.1.2, "Radiological Data Validation," and SMO-SOP-12.1.5, "Inorganic Data Validation."

7.3 Action Levels and Responses

This section of the Plan focuses on "Action Levels." An action level is defined as follows:

> A pre-specified set of criteria that, when met, triggers initiation of a pre-specified set of actions (i.e., a response scenario) by designated parties.

For ANL-W site monitoring activities, the following three action levels have been established:

- Routine (no action)

- Unusual Occurrence

- Environmental Occurrence.

The three levels are hierarchical, with environmental occurrence representing the most severe level of contamination. These three levels are discussed below.

7.3.1 Routine Action Level and Response

The Routine action level represents the "normal" response and reporting done as a part of routine monitoring activities. The Routine action level includes all analytical results in which a groundwater contaminant is:

- Not detected above background concentrations
- Measured at a contaminant level that is ≤ 50% of that parameter's Maximum Contaminant Level (MCL) or Risk-Based Concentration (RBC)
- Through trend analysis, is not projected to exceed 80% of that parameter's MCL/RBC in the future.

The response requirements for samples classified as "Routine" is discussed below.

Once validated, all groundwater monitoring data will be transmitted in hard copy and electronic form to ANL-W for evaluation. ANL-W will evaluate and summarize the data. Data will be included in an annual area-specific report to the WAG managers.

7.3.2 Unusual Occurrence Action Levels and Responses

The Unusual Occurrence (UO) action level and response scenarios were developed to meet the reporting and response requirements of DOE Order 5000.3B, "Occurrence Reporting and Processing of Operations Information," for site monitoring activities. Besides the requirements of DOE Order 5000.3B, two site-specific responses and reporting subcategories (i.e., action levels) have been developed as best management practices (BMPs). The UO action levels and their required responses are discussed below. More specific details for reporting an UOR event are presented in Section 8.3.

7.3.2.1 Unusual Occurrence Action Level and Response The general requirements for reporting and responding to "unusual occurrences" are established in DOE Order 5000.3B. According to DOE Order 5000.3B (Attachment I, Group 3 C), a discovery of new groundwater contamination above background levels is classified as an "Unusual Occurrence" and requires specific reporting and response actions to be conducted. Therefore, groundwater contamination will be classified as a UO when the following criteria are met:

- Analytical results for groundwater contaminants significantly exceed the established ANL-W background levels for the specific constituent; **and**

- Groundwater contaminants have not been previously reported in either an annual report at the UO or environmental occurrence action level or in any CERCLA/RCRA activity report at the particular sampling location (i.e., well).

Besides meeting the Routine response requirements outlined in Section 7.3.1, the following "special" response requirements must be met. Upon discovery of groundwater samples at the UOR action level, the sample results will be revalidated. If the revalidated results are questionable (i.e., extremely outside anticipated results), the well in question will be resampled and the samples will be analyzed as soon as practical. No response actions are required until confirmatory samples have been analyzed and the results are validated and evaluated. If the results of the confirmatory sample show that the initial sample results were in error (i.e., cannot be replicated and are below the Unusual Occurrence action level), the results of both the initial and follow-up sampling will be noted. No further response actions will be required.

If the results of the revalidation/resample confirm that the contaminants exceed the action level for a UO, the event will be classified as an unusual occurrence according to DOE Order 5000.3B. ANL-W will verbally notify the DOE-ARG and the WAG managers. ANL-W, and DOE-ARG will then initiate the UO reporting process, as required in DOE Order 5000.3B. Refer to DOE Order 5000.3B for the specific details of the UO reporting process. Formal written notification to the WAG managers will be included as part of the formal UO reporting process.

7.3.2.2 Site-Specific Action Level and Response Two site-specific subcategories have been established within the UO action level. These subcategories are the "Moderate Concern" action level and "Significant Concern" action level. These response categories are hierarchical, with Significant Concern being the most severe. The purpose of these subcategories is to establish graded criteria for conducting additional INEL-specific response actions, and for developing UO follow-up reports according to DOE Order 5000.3B. These INEL-specific action levels and their required responses are discussed below.

7.3.2.2.1 Moderate Concern Action Level
Groundwater contamination will be classified as a Moderate Concern when the following criteria are met:

- Analytical results, for groundwater contaminants, are greater than 50% of the Maximum Contaminant Level (MCL/RBC); and/or

- Based on trend analysis, the projected concentration will exceed 80% of the MCL/RBC within two years.

Upon discovery of groundwater samples at the Moderate Concern action level, the sample results will be revalidated. If the results are questionable, the well in question will be resampled and the samples will be analyzed as soon as practical. No response actions are required until the revalidation is complete or the confirmatory samples have been analyzed and the results are evaluated. If the results of the confirmatory sample show that the initial sample results were in error (i.e., cannot be replicated and are below the Moderate Concern action level), the results will be reclassified. That is, the results will be classified as either routine or UO, and action will be taken accordingly.

If the results of the revalidation/resample confirm that the contaminants exceed the Moderate Concern action level, ANL-W will verbally notify the DOE-ARG and the WAG managers. ANL-W, and DOE-ARG, will meet to assess the available data and information. At a minimum, they will reevaluate the potential sources of contamination and recommend corrective actions. An informal Moderate Concern Response report will then be generated by ANL-W and submitted to DOE-ARGand the WAG managers. The results will also be summarized in the annual report on groundwater monitoring activities.

7.3.2.2.2 Significant Concern Action Level

Groundwater contamination at the ANL-W will be classified as a Significant Concern when the following criteria are met:

- Analytical results for groundwater contaminants are greater than 80% of the RBC; and/or

- Based on trend analysis, the projected concentration will exceed 80% of the RBC within six months.

Upon discovery of groundwater samples at the Significant Concern action level, the sample results will be revalidated. If the results are questionable, the well in question will be resampled and the samples will be analyzed as soon as practical. No response actions are required until the revalidation or the confirmatory samples have been analyzed and the results are evaluated. If the results of the confirmatory resample show that the initial sample results were in error (i.e., cannot be replicated and are below the significant finding response level), the results will be reclassified. That is, the results will be classified as either routine, a UO, or Moderate Concern, and action will be taken accordingly.

If the results of the revalidation/resample confirm that the contaminants exceed the Significant Concern action level, ANL-W will verbally notify the DOE-ARG and WAG managers. ANL-W, and DOE-ARG will meet as soon as practical after confirming the sample results. At a minimum, they will reevaluate the potential sources of contamination, develop a corrective action plan, and if possible/practical, initiate corrective actions.

A formal Significant Concern Response report will then be generated by ANL-W and submitted to DOE-ARG. The report will be transmitted to the WAG managers. ANL-W will summarize the findings, including all follow-up actions taken, in the annual groundwater report. Once a Significant Concern has been detected, a statistical sampling plan will be developed, and it will be carried out during the next sampling round. Statistical sampling will continue until the WAG managers have determined that the level of the contaminant has decreased to an acceptable level or that sufficient data have been collected.

7.3.3 Environmental Occurrence Action Level and Response

The Environmental Occurrence action level is reached when contaminants are detected in groundwater at levels greater than a DOE or regulatory threshold. Consistent with the hierarchical structure of the action levels, this scenario includes reporting according to DOE Order 5000.3B.

Upon initial discovery of groundwater samples at the Environmental Occurrence action level, the sample results will be revalidated, and two groundwater samples will be collected from the well in question. The samples will be analyzed as soon as possible. If the results of the revalidation show that the Environmental Occurrence action level has been exceeded, the ANL-W will verbally notify the Director of DOE-ARG and WAG managers.

ANL-W will immediately notify the DOE-ARG and WAG managers regarding the results of the resampling. If the results of the revalidation and confirmatory resample show that the initial sample results were in error (i.e., cannot replicate the initial sample results and are below the Environmental Occurrence response level), the results will be reclassified (e.g., as Routine or UO) as necessary.

If the results confirm the initial sampling results, the groundwater team will immediately notify the DOE-ARG and the WAG managers. Then follow up notification(s) with an Environmental Occurrence report (see Section 8.3) and other notifications, if necessary (e.g., RCRA or CERCLA reporting) will be done. If the occurrence is due solely to exceeding a DOE threshold, the DOE-ARG Deputy Manger for Operations will inform DOE-HQ within 72 hours and a formal investigation may be convened according to the requirements of DOE Order 5484.1. If the occurrence is due to exceeding a regulatory threshold, the notification will be made following the specific regulatory requirements (e.g., see Section 7.4) beyond meeting the requirements of DOE Order 5484.1. Copies of the Environmental Occurrence report and any additional regulatory notifications will be transmitted to the Director of the DOE-ARG and the WAG managers.

Once contamination has been detected at an environmental occurrence action level, a statistical sampling plan will be developed and carried out during the next sampling round. This sampling plan will outline the number of samples required to allow for a statistical evaluation of constituents to be made at the well in question as well as up gradient and other wells in the area. Statistical sampling will be continued until the WAG managers have determined that contamination has decreased to an acceptable level or that sufficient data have been collected.

7.4 Regulatory Action Levels

Compliance monitoring activities at ANL-W include groundwater monitoring according to CERCLA regulations. In this instance, adherence to both the appropriate DOE and site-specific regulatory action levels and associated responses is required. The site-specific responses are discussed in Section 7.3.3. The CERCLA action levels and responses are discussed below.

7.4.1 CERCLA Action Levels

All CERCLA characterization and cleanup response actions at the INEL are under the jurisdiction of the INEL FFA/CO. Section 1.3.2 (Integration with Other Programs) of the FFA/CO Action Plan states that "releases or threatened releases of hazardous substances under regulatory programs that require investigation and study for cleanup are addressed under this Action." CERCLA action levels are addressed in the INEL FFA/CO and other documents and will not be presented.

In case of the detection of a new pollutant or hazardous substance at or above the significant contamination level (i.e., a significant concern or an environmental occurrence) by the WAG-9 Groundwater Monitoring Program, the initial notifications will be made by ANL-W. ANL-W EWM will notify DOE-ARG. Follow up notification will by made by the Director, DOE-ARG through the transmittal of a copy of the appropriate action level report to the WAG managers.

If groundwater monitoring or characterization results show that CERCLA or SARA reportable quantities (RQ's), as listed in 40 CFR 302, Table 302.4 or 40 CFR 355 Appendix A and B, have been exceeded, the director of the appropriate DOE organization will ensure that proper reporting is carried out according to applicable regulatory and DOE requirements.

8.0 DATA MANAGEMENT AND REPORTING

Groundwater information at ANL-W is collected by ANL-W EWM personnel. The purpose of this section is to outline the minimum data management and reporting requirements for data and information collected under the WAG-9 Groundwater Monitoring Program. The primary data management and reporting objectives for the WAG-9 Groundwater Monitoring Program are:

- Establish a well-defined and consistent process
- Integrate all pertinent groundwater monitoring data and information with the various INEL groundwater sampling organizations
- Ensure the maximum availability and usefulness of the data and information collected
- Maximize the use of existing information system resources.

Data management and reporting practices for observational monitoring and compliance monitoring can vary. Where appropriate, distinctions are made regarding these practices.

8.1 Records Management

A record is broadly defined as " . . . papers or other documentary materials, regardless of their physical form, that are made or received in the course of public business and are worth preserving temporarily or permanently." (DOE Order 724.5, "Records Management Program").

All original records generated under the WAG-9 Groundwater Monitoring Plan, or under any of its implementing appendices or procedures, will be retained by ANL-W as permanent project records. These records will be maintained in a record management system by the appropriate organization. The record's management system will meet the requirements in the INEL FFA/CO, DOE Order 1324.2A, "Records Disposition" and the QA records requirements as stated in the Quality Assurance Project Plan for Groundwater Monitoring Activities at Argonne National Laboratory - West (ANL-W)

Hard and electronic copies of all appropriate records will be maintained in a central groundwater data repository. The records developed from the data/information submitted by ANL-W will be maintained in a management system that:

- Meet the requirements of the INEL FFA/CO and DOE Order 1324.2A
- Ensures that WAG-9 Groundwater Monitoring Program records are generated, identified, authenticated, and indexed, and that they are retrievable
- Ensures that records are maintained, until disposition, in Records Storage.

At a minimum, WAG-9 Groundwater Monitoring Program records will include the following:

- Laboratory and field analytical data (raw and summarized)
- Sample management and tracking records
- Field logs
- Document control records
- Sample validation and evaluation records
- Evaluations of sampling results
- Deliverable reports
- QA records and documentation.

Copies of all groundwater data collected by this program represent official records. These records will be retained throughout the duration of the active and closure/D&D phases of the applicable facility or facilities or for a minimum of 10 years, whichever is longer. After this period, DOE will notify EPA and/or IDHW, as appropriate, at least 45 days before destruction or disposal of any such records. Electronic copies of all information will be maintained according to section 8.2 and as part of the administrative record.

Copies of data used in selection of response actions for the FFA/CO will be maintained according to Section 20.1 of the FFA/CO. An Administrative Record and Index have been established for all INEL CERCLA response actions, according to the FFA/CO.

8.2 Data Management

A data management plan is necessary to ensure effective management of data generated or used for WAG-9 Groundwater Monitoring Program activities. Data management practices will be established that ensure data are technically valid and meet all regulatory and programmatic requirements.

ANL-W is responsible for maintaining a copy of all groundwater monitoring data in a central data management system. Hard and electronic copies of all groundwater data submitted to the WAG managers in support of the WAG-9 Groundwater Monitoring Program will be maintained in this system. The system will be accessible by all INEL groundwater monitoring and groundwater-related programs.

8.2.1 Compliance Monitoring Data Management

All raw analytical data will be validated, summarized, and maintained by ANL-W following its organization-specific data management requirements. At a minimum, ANL-W has the following responsibilities for data management:

- Ensure that data are readily accessible and retrievable
- Maintain hard and electronic copies of all analytical results for both regular and QA samples
- Ensure that data are maintained in a controlled environment, with respect to both access and changes to the data
- Ensure that data base structures are compatible with the data structures for the central repository for INEL Groundwater Monitoring Program data (ERIS) and that data is also supplied to the INEL Hydrogeologic Data Repository.

Hard copies of all analytical results data are transmitted to DOE-ARG and WAG managers. Responsibility for validation of all data, before submittal resides with the data submitter.

All groundwater monitoring information and data collected under theWAG-9 Groundwater Monitoring Program will be made available to the INEL ERP through the INEL CERCLA administrative records' repository, the INEL Hydrogeologic Data Repository, and the Environmental Restoration Information System (ERIS) data base.

8.3 Data Reporting

Routine and special reporting will be done in conjunction with ANL-W monitoring activities. Routine reports will be written and transmitted to DOE-ARG for submission to the WAG-9 managers. Special reports will be written and transmitted to DOE-ARG in response to detecting groundwater contamination that exceeds the action levels described in Section 7. All deliverable reports, and data included in these reports, will be reviewed for compliance with applicable quality plan requirements, before submittal. Review documentation and all deliverable reports will be retained as permanent project quality records according to the applicable requirements for "Quality Assurance Records" or "Quality Records" for each sampling organization, and the requirements of Section 8.1.

8.3.1 Routine Reporting

Routine reporting for WAG-9 groundwater monitoring activities consists of:

- Area-specific Groundwater Quality Reports
- CERCLA Reports

- The annual ANL-W Environmental Surveillance Report
- Input to the Annual INEL Environmental Monitoring report.

8.3.2 Action Level Reporting

Site-specific action level criteria and their required response scenarios were presented in Section 7. These response scenarios include routine and additional (special) reporting requirements. The reporting and reports done as a part of action level response scenarios are discussed below. All reports referenced are generated only after the original sampling results have been validated, confirmatory samples have been collected, and the results confirm the initial sampling results.

8.3.2.1 Routine Action Level Reporting No additional reports are produced in conjunction with this action level.

8.3.2.2 Unusual Occurrence (UO) Action Level Reporting If a contaminant(s) is detected which meets the UO action level criteria outlined in Section 7.2.2, the minimum response will be to meet all Occurrence Reporting requirements specified in DOE Order 5000.3B, Attachment II. In addition, if a Moderate Concern or a Significant Concern action level is exceeded, then an informal Moderate Concern report or a formal Significant Concern report will be produced. These reports will be written by ANL-W and will be based on the available sampling and operations information. In addition, the contents of the Significant Concern report will incorporate the recommendations of the WAG-9 managers. Each report will describe the situation (e.g., quantity, type, and location of the contamination), the probable sources of contamination, additional monitoring requirements, and corrective actions taken or that should be taken to mitigate the release or spread of contamination.

Each report will be transmitted by ANL-W, as soon as practical to the Director, DOE-ARG for concurrence. The Significant Concern report is then transmitted to the WAG managers.

8.3.3.3 Environmental Occurrence Reporting If a groundwater contaminant is detected which meets the Environmental Occurrence action level criteria outlined in Section 7.3.3, an Environmental Occurrence report will be prepared according to the requirements of DOE Orders 5484.1 and 5000.3B.

If a release of a groundwater contaminant that exceeds either a DOE standard or a regulatory threshold (e.g., CERCLA RQ or MCL) is discovered during monitoring, ANL-W will immediately notify DOE-ARG. The DOE-ARG contact for groundwater issues will immediately notify the WAG managers.

The notification will be followed up by a written summary report. ANL-W will report directly to DOE-ARG. The DOE-ARG will report to the WAG managers.

If there is an environmental occurrence caused solely by exceeding a DOE action level, the DOE-CH Deputy Manager for Operations will inform DOE-HQ within 72 hours and a formal investigation may be convened according to the requirements of DOE Order 5484.1. The Environmental Occurrence report will be written by ANL-W and forwarded to the DOE-ARG as soon as possible. At a minimum the report will describe the situation (e.g., quantity, type, and location of the contamination), the probable sources of contamination, additional monitoring requirements, and corrective actions taken or that should be taken to mitigate the source of contamination.

If resampling confirms that a regulatory threshold has been exceeded, DOE-ARG, and ANL-W will jointly notify the DOE Headquarters Emergency Operations Center (EOC) as required by any applicable regulations, and also the facility landlord and the WCC. Notification to WAG managers and any other regulatory agency of any significant release will be concurrent with notification of the DOE-HQ EOC. The discovery of a release of any CERCLA hazardous substance greater than a reportable quantity (40 CFR 302.4 and 302.5) will be reported to the National Response Center according to 40 CFR 302.6. The discovery of an EPA Interim Primary Drinking Water Standards (40 CFR 265, Appendix III) being exceeded at a RCRA Interim Status facility, unless superseded by the FFA/CO, will be reported through DOE-ARG to the Director of the Idaho Department of Health and Welfare (IDHW) according to 40 CFR 265.94. Nonperiodic notification requirements are addressed in 40 CFR 265.94, and will take precedence over the requirements above for RCRA facilities. Where applicable, existing reporting formats will be used.

DOE-ARG will maintain documentation of responses to environmental occurrences and have it available for regulatory agency inspectors, DOE auditors, and the public.

8.4 Coordination with Agencies and the Public

Cooperation and coordination with Federal and State WAG managers and the public is essential to maximize the efficiency and effectiveness of this program. Final copies of this Plan will be made available to the applicable federal and state agencies upon request. In addition, a summary of groundwater monitoring results will be made available to the applicable federal and state agencies and the public annually.

Information concerning the discovery of significant groundwater quality issues will be made available to the public, through DOE-ARG, as soon as practical. Significant groundwater quality issues will be reported upon confirmation that a significant problem exists and after the issue has been reviewed by DOE-CH and DOE-HQ.

According to the DOE/State of Idaho Environmental Oversight and Monitoring Agreement (DOE, 1990), DOE-ID will notify the State's designated INEL coordinator of any release of a hazardous substance, pollutant, contaminant or radioactive material at the INEL that exceeds applicable regulations, standards or permit conditions. DOE-ARG will notify the State's designated INEL coordinator by telephone of the detection of such a release. If the presence of the release is confirmed through follow-up sampling and analysis, a formal report will be made through DOE-CH to the State as soon as practical.

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Appendix A

Lithologic Logs and Well Completion Diagrams

In the interest of conservation see RI Work Plan Appendix I.

The stand alone version of this plan will include the same drawings.

Appendix B

Description of Soil Mapping Units

ABB - Aecet-Bereniceton-Bondfarm

This unit consists of shallow to deep soils on basalt plains. Parent materials of the soils contain a mixture of eolian sand (presumably originating from the Big Lost River), and glacial flour (presumably originating from receding glaciers during the Pleistocene). The soils have calcic horizons. Slopes in this mapping unit range from 0 to 25 percent. Principal natural vegetation is Wyoming big sagebrush, rabbitbrush, needle-and-thread grass, Indian ricegrass, squirreltail, and prickly pear.

COMPOSITION

Aecet soil and similar inclusions - 40%

The Aecet series consists of moderately deep (20-40"), well-drained soils that formed in reworked eolian deposits on basalt plains. Slopes range from 0 to 12 percent. Typically, the Aecet series have pale brown sandy loam surface layer to a depth of 5 inches, a pale brown clay loam subsoil, and a very pale brown clay loam substratum over bedrock at 23 inches. The principal native plants are Wyoming big sagebrush, rabbitbrush, and wheatgrasses, squirreltail and prickly pear cactus.

Bereniceton soil - 20%

Bereniceton series consists of deep (40-60"), well-drained soils formed in wind-worked material over basalt or over sand and gravel. Slopes range from 1 to 25 percent. Typically, Bereniceton series have a brown sandy loam surface to 3 inches, underlain by a pale brown loam to 14", a very pale brown clay loam subsurface, and rock at about 46". The principal natural vegetation is Wyoming big sagebrush, rabbitbrush, needle-and-thread grass, Indian ricegrass, sod wheatgrass, and squirreltail.

Bondfarm soil - 20%

The Bondfarm series consists of shallow (10-20"), well-drained soils formed in eolian material over basalt. Slopes range from 2 to 20 percent. Typically, Bondfarm series have a pale brown stony sandy loam surface underlain by pale brown cobbly sandy loam subsurface horizons, which contain evidence of silica cementation. These soils are on basalt plains and have slopes of 2 to 12 percent. The principal plants are Wyoming big sagebrush, three-tip sagebrush, small rabbitbrush, bluebunch wheatgrass, cheatgrass, needle-and-thread grass, and Indian ricegrass.

Contrasting inclusions - 20%

Soils without calcic horizons, playa soils, rock outcrop.

AECET SERIES

The Aecet series consists of moderately deep, well-drained soils that formed in reworked eolian deposits on basalt plains. The principal native plants are big sagebrush, rabbitbrush, and wheatgrasses, squirreltail and prickly pear cactus. Typically, they have pale brown sandy loam surface layer to a depth of 5 inches, a pale brown clay loam subsoil, and a very pale brown clay loam substratum over bedrock at 23 inches.

CLASSIFICATION:
Taxonomic Class: Fine-loamy, mixed, frigid Xerollic Calciorthids

SETTING
Depth Class: moderately deep (20-40")
Drainage class: well drained
Permeability: moderately slow
Positions on the landscape: plains and side slopes
Parent Material:
kind - reworked eolian deposits
source - Big Lost River
Slope range: 0 to 12 percent

TYPICAL PEDON DESCRIPTION

A1--0 to 5 inches, pale brown (10YR 6/3) very stony sandy loam, dark grayish brown (10YR 4/2) moist; weak very thin platy parting to weak very fine granular structure; loose; many very fine, fine and medium roots; slightly calcareous; moderately alkaline (pH 8.4); clear wavy boundary.

Bw--5 to 13 inches, pale brown (10YR 6/3) clay loam, brown (10YR 5/30 moist; weak fine and medium angular blocky structure; slightly hard, friable, sticky and plastic; common very fine and fine roots; many very fine tubular pores; strongly calcareous; strongly alkaline (pH 8.6); clear wavy boundary.

Bk--13 to 23 inches, very pale brown (10YR 7/3) clay loam, brown (10YR 5/3) moist; weak fine and medium subangular blocky structure; hard, friable, sticky and plastic; few very fine and fine roots; many very fine tubular pores; strongly calcareous; about 5 percent basalt pebbles and cobbles; strongly alkaline (Ph 9.0); abrupt wavy boundary.

IIR--23 inches, basalt.

TYPICAL PEDON LOCATION: Jefferson County, Idaho; 300 feet north, 1,980 feet east of the southwest corner of Section 14, T.7N., R.34E.

RANGE IN CHARACTERISTICS
Profile:
mean annual soil temperature - 41 to 45 degrees F.
mean summer soil temperature - 66 degrees F (at a depth of 20 inches)

Particle-size control section:
clay content - 18 to 35 percent

texture - loam, silt loam, sandy clay loam or clay loam
fine sand or coarser - 15 percent or more
bedrock - 20 to 40 inches
calcic horizon - depth of 5 to 17 inches
Five to ten percent angular basaltic pebbles are throughout most pedons

A horizon:
value - 5 or 6 dry
chroma - 2 or 3 dry or moist

B horizon:
value - 6 or 7 dry
chroma - 2 or 3 dry or moist

Cca horizon:
value - 7 or 8 dry
chroma - 1 to 3 dry or moist

The soils are usually dry and are dry between depths of 4 and 12 inches for a continuous period of about 70 to 90 days in the late summer.

SOIL CHARACTERISTICS

DEPTH	TEXTURE	CLAY	LIQUID LIMIT	PLASTICITY INDEX	BULK DENSITY	PERME-ABILITY	AWC	pH	Sal	SAR	CEC	CaCo3
inches	USDA	percent	percent		g/cm^3	in/hr	in/in		mmhos/cm	me/100g	meg/100g	percent
0-5	SL	5-10	20-25	NP-5	1.6-1.7	2.0-6.0	0.11-0.13	7.4-8.4		0-2	4-10	3-10
0-5	L	10-24	25-35	NP-10	1.4-1.5	0.6-2.0	0.16-0.18	7.4-8.4		0-2	8-25	3-10
0-5	SIL	14-20	25-35	5-15	1.4-1.5	0.2-0.6	0.19-0.21	7.4-7.8		0-2	10-20	3-10
5-13	CL,L,SIL	18-35	30-45	10-20	1.4-1.5	0.2-0.6	0.19-0.21	7.4-9.0	0-2	1-5	12-30	5-15
13-23	CL	18-35	30-45	10-20	1.4-1.5	0.2-0.6	0.19-0.21	7.9-9.0	0-2	1-5	12-30	15-30

AWC - Available Water Capacity
Sal - Salinity
SAR - Sodium Adsorption Ratio
CEC - Cation Exchange Capacity

BERENICETON SERIES

These soils formed in wind-worked material over basalt or over sand and gravel. The principal natural vegetation is big sagebrush, rabbitbrush, needle-and-thread grass, Indian ricegrass, sod wheatgrasses and squirreltail. Typically, Bereniceton series have a brown sandy loam surface to 3 inches, underlain by a pale brown loam to 14", a very pale brown clay loam subsurface, and rock at about 46".

CLASSIFICATION
Taxonomic Class: Fine-loamy, mixed, (calcareous), frigid Xeric Torriorthents

SETTING
Depth Class: deep (40 to 60 inches)
Drainage class: well drained
Permeability: moderately slow
Positions on the landscape:
Slope range: 1 to 25 percent
Parent Material:
kind - eolian material over basalt
source - mixture of loess from glacial outwash and sand from the Big Lost River or further alluvial sources

TYPICAL PEDON DESCRIPTION

A11--0 to 3 inches; brown (10YR 5/3) sandy loam, dark grayish brown (10YR 4/2) moist; weak very fine granular structure; slightly hard, very friable; few very fine, fine, medium and coarse roots; slightly calcareous; moderately alkaline (pH 8.4); clear wavy boundary.

A12--3 to 7 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; weak very fine granular structure; slightly hard, very friable, sticky and slightly plastic; few very fine, fine, medium and course roots; many very fine tubular pores; slightly calcareous; moderately alkaline (pH 8.4); clear wavy boundary.

C1ca--7 to 14 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; weak fine and medium subangular blocky structure; slightly hard, very friable, sticky and slightly plastic; few very fine, fine, medium and coarse roots; many very fine tubular pores; strongly calcareous; strongly alkaline (pH 8.6); clear wavy boundary.

IIC2ca--14 to 30 inches, very pale brown (10YR 7/3) clay loam, pale brown (10YR 6/3) moist; moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; few very fine and fine roots; many very fine tubular pores; strongly calcareous; common cicada nodules; strongly alkaline (pH 8.8); clear wavy boundary.

IIC3ca--30 to 46 inches; very pale brown (10YR 7/3) clay loam, pale brown (10YR 6/3) moist; massive; hard, friable, sticky and plastic; few very fine roots; many very fine tubular pores; strongly calcareous; common cicada nodules; strongly alkaline (pH 8.8).

IIIR--46 inches, basalt.

TYPICAL PEDON LOCATION: Jefferson County, Idaho; 1,950 feet north, 2,000 feet east of the SW corner of Section 16, T. 4N., R. 34E.

RANGE IN CHARACTERISTICS

Profile:

average annual soil temperature - 41 to 46 degrees F
mean summer soil temperature - 64 to 67 degrees F (at 20 inches)
depth to bedrock, sand, and gravel - 40 to 60 inches
reaction - mildly, moderately or strongly alkaline (pH 7.8 to 9.0)

Particle-size control section:

clay - 18 to 35 percent
coarse fragments - up to 10 percent basalt pebbles and cobbles
other - soils usually dry, and are dry between 4 to 12 inches for a continuous period of about 70 to 90 days in late summer

All horizon:

value - 5 or 6 dry
chroma - 2 or 3 dry or moist

C horizon:

value - 6 to 8 dry
texture - loam, clay loam, or sandy clay loam.

ASSOCIATED SOILS

Associated soils are Aecet, Bondfarm and Lidy series. Aecet soils are underlain by bedrock at depths of 20 to 40 inches. Bondfarm soils are underlain by bedrock at depths of 10 to 20 inches. Lidy soils are 20 to 40 inches deep over sand and gravel.

SOIL CHARACTERISTICS

DEPTH	TEXTURE	CLAY	LIQUID LIMIT	PLASTICITY INDEX	BULK DENSITY	PERME-ABILITY	AWC	pH	Sal	SAR	CEC	$CaCo_3$
inches	USDA	percent	percent		g/cm^3	in/hr	in/in		mmhos/cm	me/100g	meg/100g	percent
0-8	SIL	20-27	25-35	5-10	1.35-1.50	0.2-0.6	0.15-0.17	7.9-8.4	2-4	-	-	-
0-8	GR-L	16-22	25-35	5-10	1.45-1.55	0.6-2.0	0.11-0.14	7.9-8.4	2-4	-	-	-
8-60	L,SIL,SICL	18-30	25-35	5-15	1.40-1.50	0.2-0.6	0.14-0.18	7.9-8.4	2-4	-	-	-

AWC - Available Water Capacity
Sal - Salinity
SAR - Sodium Adsorption Ratio
CEC - Cation Exchange Capacity

BONDFARM SERIES

The Bondfarm series consists of shallow, well drained soils that formed in eolian material over basalt. These soils are on basalt plains and have slopes of 2 to 12 percent. The mean annual precipitation is about 9 inches. The principal plants are big sagebrush, three-tip sagebrush, small rabbitbrush, bluebunch wheatgrass, cheatgrass, needle-and-thread grass, and Indian ricegrass.

CLASSIFICATION
Taxonomic Class: Loamy, mixed, frigid Lithic Xerollic Calciorthids

SETTING
Depth Class: shallow (10 to 20 inches to basalt bedrock)
Drainage class: well drained
Positions on the landscape: basalt uplands
Slope range: 2 to 20 percent
Parent Material:
kind - eolian
source - wind blown sandy material from Big Lost River alluvium

TYPICAL PEDON DESCRIPTION (DG79-1)

A--0 to 2.5 inches; pale brown (10YR 6/3) stony sandy loam, dark brown (10YR 3/3) moist; common thin platy structure; slightly hard, slightly friable, nonsticky and nonplastic; common very fine roots; 5 percent gravel, 5 percent stones and 10 percent cobble basalt rock fragments; mildly alkaline (pH 7.8); clear smooth boundary.

Bkq1--2.5 to 7 inches: pale brown (10YR 6/3) cobbly sandy loam, dark brown (10YR 3/3) moist; common fine subangular blocky structure; soft, friable, nonsticky and nonplastic; few fine and very fine roots; few very fine tubular pores; 5 percent gravel, 10 percent cobbles and 2 percent stones basalt rock fragments; strongly effervescent (16 percent calcium carbonate equivalent); 1-2 mm silica pendants under rock fragments; moderately alkaline (pH 8.0); clear smooth boundary.

Bkq2--7 to 11 inches: pale brown (10YR 6/3) cobbly sandy loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; soft, friable, nonsticky and nonplastic; few fine, very fine and medium roots; few very fine tubular pores; 5 percent gravel, 10 percent cobbles and 2 percent stones basalt rock fragments; strongly effervescence (20 percent calcium carbonate equivalent); 1-2 mm silica pendants under rock fragments; moderately alkaline (pH 8.0); abrupt smooth boundary.

2R--11 inches: lime-coated, unfractured basalt bedrock.

TYPICAL PEDON LOCATION: Butte County, Idaho; approximately 1,600 feet south and 1,000 west of the northeast corner of Section 13, T. 3N., R. 27E.

RANGE IN CHARACTERISTICS
Profile:
Average annual soil temperature - 45 to 55 degrees F.

Particle-size control section:
- clay content - 15 to 20 percent
- depth to basalt bedrock 10 to 20 inches
- rock fragment content - 15 to 25 percent

A horizon:
- value - 5 or 6 dry; 3 or 4 moist
- chroma - 2 or 3 dry or moist
- texture - cobbly sandy loam, stony loam
- reaction - mildly or moderately alkaline
- rock fragment content - 15 to 20 percent

Bk horizon:
- value - 5 or 6 dry; 3 or 4 moist
- chroma - 2 or 4 dry or moist
- texture - stony sandy loam, stony loam
- reaction - mildly or moderately alkaline
- rock fragment content - 15 to 35 percent

The mean annual soil temperature ranges from 41 degrees to 45 degrees F, and the mean summer soil temperature at the lithic contact ranges from 63 degrees to 66 degrees F. The soils are usually dry but are moist in some part between a depth of 8 inches and bedrock for 60 to 80 days in the spring. The organic matter content of the upper 15 inches (or to bedrock if shallower) averages more than 0.6 percent if the weighted average sand/clay ratio for this depth is 6. The control section is dominantly moderately-coarse textured.

SOIL CHARACTERISTICS

DEPTH	TEXTURE	CLAY	LIQUID LIMIT	PLASTICITY INDEX	BULK DENSITY	PERME-ABILITY	AWC	pH	Sal	SAR	CEC	$CaCo_3$
inches	USDA	percent	percent		g/cm^3	in/hr	in/in		mmhos/cm	me/100g	meg/100g	percent
0-4	SL,FSL	5-15	20-30	NP-5	1.5-1.6	2.0-6.0	0.11-0.13	7.9-8.4	-	-	5-10	5-10
0-4	LS	2-8	-	NP	1.5-1.6	2.0-6.0	0.06-0.08	7.9-8.4	-	-	1-5	5-10
0-4	L	18-25	30-35	10-15	1.5-1.6	0.6-2.0	0.16-0.18	7.4-8.4	0-2	-	-	15-20
4-18	SL,FSL,L	15-18	20-30	NP-10	1.5-1.6	2.0-6.0	0.11-0.13	7.9-8.4	0-2	-	-	4-10

AWC - Available Water Capacity
Sal - Salinity
SAR - Sodium Adsorption Ratio
CEC - Cation Exchange Capacity

Appendix C

Well Sample Result Tables

In the interest of conservation see RI Work Plan Appendix H.

The stand alone version of this plan will include the same drawings.

Appendix D

Monitoring Efficiency Model Input Parameters Used for WAG-9 Runs

```
++++++++++++++++++++++++++++++++++++++++++++
++        MEMO Data File                  ++
++                                        ++
++     Monitoring Analysis Package        ++
++        MAP Version   1.1               ++
++                                        ++
++       GOLDER ASSOCIATES INC.           ++
++                                        ++
++    Run on 06/13/96 at 15:10:06         ++
++++++++++++++++++++++++++++++++++++++++++++


--------------------------------------------
< WAG-9, sewage lagoons                    >
--------------------------------------------


*   SCALE FACTOR
      1.000000
*   SOURCE GRID PARAMETERS (x0,y0,grid spacing,max x incr,max y incr)
  10746.500000     4291.000000       10.000000
        48           73
*   POTENTIAL SOURCE AREA COORDINATES (#,x,y,unit#)
  1        11187.80         4291.40           1
  2        10889.60         4291.00           1
  3        10746.50         4337.90           1
  4        10746.50         4537.90           1
  5        11116.50         5012.10           1
  6        11220.70         4944.80           1
  7        11187.80         4291.40           1
*   LINE OF COMPLIANCE COORDINATES (#,x,y)
  1        10085.50         3376.60
  2         9900.00         4200.00
  3         9900.00         5100.00
  4        11300.00         5100.00
  5        11300.00         3376.60
  6        10085.50         3376.60
*   ARRAY SPACING FOR BUFFER ZONE COORDINATES (max. spacing)
     35.000000
*   INPUT BUFFER ZONE COORDINATES (#,x,y)
  1         9500.00         2700.00
  2         9000.00         4100.00
  3         9000.00         5200.00
  4        11400.00         5200.00
  5        11400.00         2700.00
  6         9500.00         2700.00
*   MONITORING WELL COORDINATES (#,x,y)
  1        10085.50         3376.60
*   CONTAM. TRAN. PARAMETERS (CD/C0,ldisp,tdisp,diffc,source width,lmb,cvel)
  1.000000E-03       70.000000       20.000000     0.000000E+00
     50.000000     0.000000E+00     1.000000E-01
*   GRADIENT ZONE COORDINATES (#,x,y,unit#,angle)
  1        10085.50         3376.60           1            225.00
  2         9900.00         4200.00           1            225.00
  3         9900.00         5100.00           1            225.00
  4        11300.00         5100.00           1            225.00
  5        11300.00         3376.60           1            225.00
  6        10085.50         3376.60           1            225.00
```

```
 *   SOLUTION RESULTS
 Maximum advection time =     36500.000000
 Accuracy of solution =    1.000000E-04
 Solution basis = buffer zone/advection time
  otal # of source points =        2359
  of undetected leaks =            0
Monitoring efficiency =100.0 %.
 *   END OF MAP FILE
```

```
++++++++++++++++++++++++++++++++++++++++++++
++         MEMO Data File                 ++
++                                        ++
++      Monitoring Analysis Package       ++
++         MAP Version   1.1              ++
++                                        ++
++        GOLDER ASSOCIATES INC.          ++
++                                        ++
++     Run on 06/13/96 at 15:11:26        ++
++++++++++++++++++++++++++++++++++++++++++++



--------------------------------------------
< WAG-9, leach pit only                    >
--------------------------------------------



*   SCALE FACTOR
      1.000000
*   SOURCE GRID PARAMETERS (x0,y0,grid spacing,max x incr,max y incr)
   9908.000000     2505.000000       1.000000
       13            124
*   POTENTIAL SOURCE AREA COORDINATES (#,x,y,unit#)
  1         9908.00         2628.00         1
  2         9920.00         2628.00         1
  3         9920.00         2505.00         1
  4         9908.00         2505.00         1
  5         9908.00         2628.00         1
*   LINE OF COMPLIANCE COORDINATES (#,x,y)
  1         9697.00         2420.00
  2         9600.00         2575.00
  3         9600.00         2675.00
  4        10000.00         2675.00
  5        10000.00         2400.00
  6         9725.00         2400.00
  7         9697.00         2420.00
*   ARRAY SPACING FOR BUFFER ZONE COORDINATES (max. spacing)
      7.500000
*   INPUT BUFFER ZONE COORDINATES (#,x,y)
  1         9725.00         2250.00
  2         9500.00         2575.00
  3         9500.00         2750.00
  4        10100.00         2750.00
  5        10100.00         2250.00
  6         9725.00         2250.00
*   MONITORING WELL COORDINATES (#,x,y)
  1         9697.00         2420.00
*   CONTAM. TRAN. PARAMETERS (CD/C0,ldisp,tdisp,diffc,source width,lmb,cvel)
  1.000000E-03       70.000000       20.000000     0.000000E+00
     50.000000    0.000000E+00     1.000000E-01
*   GRADIENT ZONE COORDINATES (#,x,y,unit#,angle)
  1         9725.00         2400.00         1         225.00
  2         9600.00         2575.00         1         225.00
  3         9600.00         2675.00         1         225.00
  4        10000.00         2675.00         1         225.00
  5        10000.00         2400.00         1         225.00
  6         9725.00         2400.00         1         225.00
*   SOLUTION RESULTS
```

```
Maximum advection time =    73000.000000
Accuracy of solution =    1.000000E-04
Solution basis = buffer zone/advection time
Total # of source points =        1601
# of undetected leaks =         0
Monitoring efficiency =100.0 %.
*   END OF MAP FILE
```

```
++++++++++++++++++++++++++++++++++++++++++++
++         MEMO Data File                  ++
++                                         ++
++      Monitoring Analysis Package        ++
++         MAP Version   1.1               ++
++                                         ++
++        GOLDER ASSOCIATES INC.           ++
++                                         ++
++     Run on 06/13/96 at 15:08:46         ++
++++++++++++++++++++++++++++++++++++++++++++


--------------------------------------------
< WAG-9, pond only                         >
--------------------------------------------


*    SCALE FACTOR
       1.000000
*    SOURCE GRID PARAMETERS (x0,y0,grid spacing,max x incr,max y incr)
   9500.000000     3840.000000       20.000000
        19            36
*    POTENTIAL SOURCE AREA COORDINATES (#,x,y,unit#)
  1        9720.00        3840.00         1
  2        9574.00        3988.00         1
  3        9500.00        4282.00         1
  4        9540.00        4282.00         1
  5        9550.00        4216.00         1
  6        9640.00        4180.00         1
  7        9798.00        4544.00         1
  8        9862.00        4508.00         1
  9        9720.00        3840.00         1
*    LINE OF COMPLIANCE COORDINATES (#,x,y)
  1        9500.00        3200.00
  2        8918.00        3507.00
  3        8918.00        4600.00
  4       10000.00        4600.00
  5       10000.00        3200.00
  6        9500.00        3200.00
*    ARRAY SPACING FOR BUFFER ZONE COORDINATES (max. spacing)
     25.000000
*    INPUT BUFFER ZONE COORDINATES (#,x,y)
  1        9400.00        2800.00
  2        8600.00        3300.00
  3        8600.00        4800.00
  4       10200.00        4800.00
  5       10200.00        2800.00
  6        9400.00        2800.00
*    MONITORING WELL COORDINATES (#,x,y)
  1        8918.00        3507.00
*    CONTAM. TRAN. PARAMETERS (CD/C0,ldisp,tdisp,diffc,source width,lmb,cvel)
  1.000000E-03       70.000000       20.000000    0.000000E+00
     50.000000    0.000000E+00    1.000000E-01
*    GRADIENT ZONE COORDINATES (#,x,y,unit#,angle)
  1        9500.00        3200.00         1         225.00
  2        8918.00        3507.00         1         225.00
  3        8918.00        4600.00         1         225.00
  4       10000.00        4600.00         1         225.00
```

```
   5      10000.00        3200.00          1          225.00
   6       9500.00        3200.00          1          225.00
 *   SOLUTION RESULTS
 Maximum advection time =    36500.000000
 Accuracy of solution =    1.000000E-04
 Solution basis = buffer zone/advection time
 Total # of source points =        250
 # of undetected leaks =         0
Monitoring efficiency =100.0 %.
 *   END OF MAP FILE
```

```
+++++++++++++++++++++++++++++++++++++++++++
++        MEMO Data File                 ++
++                                       ++
++     Monitoring Analysis Package       ++
++        MAP Version   1.1              ++
++                                       ++
++       GOLDER ASSOCIATES INC.          ++
++                                       ++
++    Run on 06/13/96 at 14:58:16        ++
+++++++++++++++++++++++++++++++++++++++++++


-------------------------------------------
< WAG-9, ditches only                      >
-------------------------------------------


*   SCALE FACTOR
     10.000000
*   SOURCE GRID PARAMETERS (x0,y0,grid spacing,max x incr,max y incr)
  97130.000000    27910.000000      100.000000
        68          109
*   POTENTIAL SOURCE AREA COORDINATES (#,x,y,unit#)
  1         9818.00         3849.00        1
  2         9713.00         3849.00        1
  3         9713.00         3877.00        1
  4         9840.00         3877.00        1
  5         9840.00         3673.00        1
  6        10021.00         3553.00        1
  7        10387.00         3553.00        1
  8        10387.00         3535.00        1
  9        10000.00         3535.00        1
 10         9840.00         3655.00        1
 11         9840.00         3380.00        1
 12         9943.00         3380.00        1
 13         9943.00         3230.00        1
 14         9926.00         3230.00        1
 15         9926.00         3364.00        1
 16         9840.00         3364.00        1
 17         9840.00         2899.00        1
 18         9943.00         2813.00        1
 19        10039.00         2813.00        1
 20        10091.00         2867.00        1
 21        10100.00         2860.00        1
 22        10039.00         2791.00        1
 23         9943.00         2791.00        1
 24         9818.00         2899.00        1
 25         9818.00         3849.00        1
*   LINE OF COMPLIANCE COORDINATES (#,x,y)
  1         9697.00         2420.00
  2         9200.00         2800.00
  3         8918.00         3200.00
  4         8918.00         3507.00
  5         8918.00         4600.00
  6        11000.00         4600.00
  7        11000.00         2420.00
  8         9697.00         2420.00
*   ARRAY SPACING FOR BUFFER ZONE COORDINATES (max. spacing)
```

```
   500.000000
*   INPUT BUFFER ZONE COORDINATES (#,x,y)
  1        9697.00        2200.00
  2        9100.00        2600.00
  3        8700.00        3200.00
  4        8700.00        3507.00
  5        8700.00        4800.00
  6       11200.00        4800.00
  7       11200.00        2200.00
  8        9697.00        2200.00
*   MONITORING WELL COORDINATES (#,x,y)
  1        9697.00        2420.00
  2        8918.00        3507.00
  3       10085.50        3376.60
*   CONTAM. TRAN. PARAMETERS (CD/C0,ldisp,tdisp,diffc,source width,lmb,cvel)
  2.000000E-02       70.000000       20.000000     0.000000E+00
   250.000000     0.000000E+00    1.000000E-01
*   GRADIENT ZONE COORDINATES (#,x,y,unit#,angle)
  1        9697.00        2420.00         1         225.00
  2        8918.00        3507.00         1         225.00
  3        8918.00        4600.00         1         225.00
  4       11000.00        4600.00         1         225.00
  5       11000.00        2420.00         1         225.00
  6        9697.00        2420.00         1         225.00
*   SOLUTION RESULTS
Maximum advection time =   365000.000000
Accuracy of solution =    1.000000E-03
Solution basis = buffer zone/advection time
Total # of source points =        444
# of undetected leaks =        373
'onitoring efficiency = 16.0 %.
*   END OF MAP FILE
```

Input parameters for the one and two well cases are the same as for WAG-9, Ditches only.

For the single well case the new well is placed at coordinates 9275, 2725.

For the two well case the wells are at 9305, 2745 and 9050, 3040.

To input the new wells first choose selection **2** from the main menu. Next choose **modify**, item **5** (monitoring wells), and **review**. This will list the existing three wells. To add a new well select insert, point **4**, and input the coordinates given above. To add a second well follow the same procedure but insert point **5**. Also, in the two well case change the location of well 4 by selecting change, point **4**, and input the new coordinates.

Appendix E

Quality Assurance Project Plan for Groundwater Activities at Argonne National Laboratory

QUALITY ASSURANCE PROJECT PLAN
for
Groundwater Monitoring Activities
at
Argonne National Laboratory - West

Document Number W7500-0489-ES-01

APPROVALS

QUALITY ASSURANCE PROJECT PLAN
for
GROUNDWATER MONITORING ACTIVITIES
at
ARGONNE NATIONAL LABORATORY - WEST

Prepared by:

____ Date

Reviewed by:

____
Manager, Environment, and Waste Management Date

____
Manager, ANL-W Analytical Laboratory Date

____
Division Quality Assurance Representative Date

Approved:

____
Director, Reactor Program Services Date

____
Deputy Associate Laboratory Director for ANL-W Operations Date

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

AL	Analytical Laboratory
ALQAP	Analytical Laboratory Quality Assurance Plan
ANL-E	Argonne National Laboratory - East
ANL-W	Argonne National Laboratory - West
AOCA	Association of Official Analytical Chemists
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
CRM	Certified Reference Materials
DOE	US Department of Energy
DOE-CH	US Department of Energy - Chicago Operations Office
DOE-HQ	US Department of Energy - Headquarters Office
DOE-ID	US Department of Energy - Idaho Operations Office
DRR	Document Revision Request
EIP	Environmental Investigation Procedure
EPA	US Environmental Protection Agency
ERP	Environmental Restoration Program
ERIS	Environmental Restoration Information System
ES&H	Environment, Safety, and Health
EWM	Environment and Waste Management Section
GC/MS	Gas Chromatograph/Mass Spectrometer
GMP	Groundwater Monitoring Program
HP	Health Physics
ICP	Inductively Coupled Plasma
ICS	Interference Check Samples
INEL	Idaho National Engineering Laboratory
IRTS	INEL RCRA Technical Support
IRTS/GMP	INEL RCRA Technical Support Groundwater Monitoring Program
LCS	Laboratory Control Sample
LITCO	Lockheed Idaho Technologies Company
M&TE	Measuring and Test Equipment
NARA	National Archives and Records Administration
NCP	National Contingency Plan
NIST	National Institute of Standards and Technology
NIOSH	National Institute for Occupational Safety and Health
NPDWR	National Priority Drinking Water Regulations
NRC	Nuclear Regulatory Commission

PO&A	Performance Oversight & Assessment
PM	Program Manager
QA	Quality Assurance
QC	Quality Control
QE	Quality Engineer
QPP	Quality Program Plan
QAPjP	Quality Assurance Project Plan
RCRA	Resource and Conservation Recovery Act
RPD	Recovered Percent Difference
RFS	Radiation, Fire, Safety section
RPS	Reactor Program Services
RT	Run time
SAP	Sampling and Analysis Plan
SMO	Sample Management Office
SOP	Standard Operating Procedure
SRM	Standard Reference Materials
TCLP	Toxicity Characteristic Leaching Procedure
TIC	Tentatively Identified Compounds
TSCA	Toxic Substance Control Act
TSDF	Treatment, Storage, or Disposal Facility
USGS	United States Geological Survey

FOREWORD

Quality assurance (QA) activities for the Environment and Waste Management (EWM) section at the Argonne National Laboratory - West (ANL-W) are governed by Administrative Procedure AWP-4.2 Quality Assurance Grading. This plan for groundwater monitoring has been prepared in accordance with EPA QAMS-005/80 and DOE Orders 5400.1 and 5700.6C.

Some project elements are unique to one activity program whereas others are common to several activity programs. For associated activities that are not the direct responsibility of EWM, such as chemical analysis of samples, QA programs and plans of the activities are incorporated into the technical work plans and procedures, either directly by inclusion or by reference to the pertinent plans and programs.

A list of acronyms is provided after the Table of Contents. An appendix has been provided to define certain terms.

ENVIRONMENTAL MONITORING MATRIX

The following matrix cross-references the QAMS-005/80 elements to the DOE 5400.1 and 5700.6C criteria.

This QAPjP	QAMS-005/80	DOE 5400.1	DOE 5700.6C
Title Page	5.1 Title Page		
Table of Contents	5.2 Table of Contents		
Section 1: Project Description	5.3 Project Description	10.a.(2) Program Design 10.a.(6) Human Factors	Criterion 1. Program Management
Section 2: Project Organization and Responsibility	5.4 Project Organization and Responsibility	10.a.(1) Organization Responsibility	Criterion 2. Personnel Training & Qualifications
Section 3: QA Objectives	5.5 QA Objectives for Measurement Data in Terms of Precision, Accuracy, Completeness, Representativeness and Comparability		Criterion 3. Quality Improvements Criterion 8(b). Acceptance Testing
Section 4: Sampling Procedures	5.6 Sampling Procedures	10.a.(3) Procedures 10.a.(7) Record Keeping	Criterion 5(a). Work Criterion 5(b). Identification & Control of Items Criterion 6. Design Criterion 7. Procurement
Section 5: Sample Custody	5.7 Sample Custody	10.a.(8) Chain-of-Custody	Criterion 5(c). Handling, storage, & shipping
Section 6: Calibration Procedures and Frequency	5.8 Calibration Procedures and Frequency	10.a.(3) Procedures	Criterion 5(d). Calibration and maintenance of monitoring & data collection equipment
Section 7: Analytical Procedures	5.9 Analytical Procedures	10.a.(3) Procedures	
Section 8: Data Reduction, Validation and Reporting	5.10 Data Reduction, Validation and Reporting	10.a.(11) Independent Data Verification	
Section 9: Internal Quality Control Checks	5.11 Internal Quality Control Checks	10.a.(4) Field Quality Control 10.a.(5) Laboratory Quality Control	Criterion 8(a). Inspection Criterion 5. Calibration and maintenance of monitoring & data collection equipment
Section 10: Performance and System Audits	5.12 Performance and System Audits	10.a.(9) Audits	Criterion 9. Management Assessments Criterion 10. Independent Assessments
Section 11: Preventive Maintenance	5.13 Preventive Maintenance		Criterion 8(c). Measuring & testing equipment
Section 3: QA Objectives	5.14 Specific Routine Procedures Used to Assess Data Precision, Accuracy, and Completeness		
Section 12: Corrective Action	5.15 Corrective Action		
Section 13: Quality Assurance Reports to Management	5.16 Quality Assurance Reports to Management	10.a.(10) Performance Reporting	Criterion 4. Documents and Records Management

QUALITY ASSURANCE PROJECT PLAN
for
Groundwater Monitoring Activities
at
Argonne National Laboratory - West

This Quality Assurance Project Plan (QAPjP) for groundwater monitoring activities at the Argonne National Laboratory - West (ANL-W) serves to ensure that any groundwater data collected is of known and defensible quality and to meet the requirements of all applicable federal and state regulations and U.S. Department of Energy (DOE) orders. It applies to any groundwater data collected by ANL-W personnel. Data analysis and validation contracted through the INEL Sample Management Office will follow their QA plans that are here deemed equivalent to the following plan.

1.0 Project Description

The QAPjP for Groundwater Monitoring provides a procedural framework for the gathering of quantitative and qualitative environmental data. This data must be of known and acceptable accuracy and precision commensurate with the complexity and quality goals for such activities.

The Environment and Waste Management (EWM) section of the Reactor Program Services Division (RPS) is responsible for maintaining the groundwater monitoring program and reporting the required data. Approved, detailed procedures will be maintained, adequate training given, and documents controlled to ensure that data is of known and acceptable precision and accuracy.

Elements required by the QAPjP for Groundwater Monitoring are as follows:

- Groundwater monitoring activities are done following written procedures identified in Sections 4 through 10 of this document.
- Quantitative measurement of all monitored/sampled effluent streams is obtained by using (1) accurate and calibrated measurement equipment and (2) approved procedures. Calibration procedures are listed in Section 6 of this document.
- Qualitative analysis of all monitored/sampled effluent streams is done by using industry standard and/or U. S. Environmental Protection Agency (EPA) approved procedures for analysis; accurate, calibrated analyzing equipment; and qualified analysts.
- Periodic subcontract laboratory and internal audits are conducted, through use of known quantity samples, to determine proper use of analysis

methods and equipment following standard operating procedures (SOPs) for each aspect of environmental monitoring. Quality samples will include field duplicates, field and trip blank samples, blind samples, and others as discussed in Section 10.

- Documents such as field records, raw data, and laboratory reports are controlled to ensure validity and to allow verification of accuracy, precision, and reliability of groundwater monitoring activities. Data, calculations of results, procedures, and reports are kept on file in the EWM central file. Random subcontract calculations will be independently checked by an EWM Environmental Engineer.

The following govern the handling of designated environmental samples:

- Argonne National Laboratory-West Procedure AWP 2.8, "Chain Of Custody," Lockheed Idaho Technologies Company (LITCO) Environmental Monitoring Technical Procedure SOP-EM-CM-3.2, "Decontaminating Sampling Equipment," INEL Environmental Investigation Procedure (EIP) EIP-18 "Field Log Books," INEL EIP-10 "Chain-of-Custody, Sample Handling, and Packaging"

- In case of a procedural noncompliance, a corrective action system is implemented, sometimes requiring that sampling, analyses, and calculations be redone.

1.1 Human Factors

Provisions to ensure that human factors are given adequate consideration in personnel selection and training, design development, procedure preparation, and management change will be instituted. Positions, facilities, equipment, processes, and functions for which human factors are expected to be important will be identified, and the plans, designs, and procedures that prescribe them will be reviewed for human factor considerations. Examples of such considerations include:

- Acceptability and labeling of indicators and controls

- Work space arrangement and environment

- Protective gear

- Stress potential

- Limitations on such human capabilities as strength, reaction time, vision, hearing, and cognition.

2.0 Project Organization and Responsibility

The QAPjP for Groundwater Monitoring specifies the quality controls applicable to groundwater monitoring programs at ANL-W. The EWM Section will prepare all groundwater data reports and ensure that all groundwater sampling and data reporting are done correctly.

2.1 Reactor Program Services Division

2.1.1 Environment and Waste Management (EWM) Section

EWM will have the prime responsibility and authority for groundwater monitoring activities at ANL-W. In the past, the United States Geological Survey (USGS) has conducted limited sampling near ANL-W. Figure 1 shows the hierarchical structure of the ANL-W groundwater program within the RPS Division.

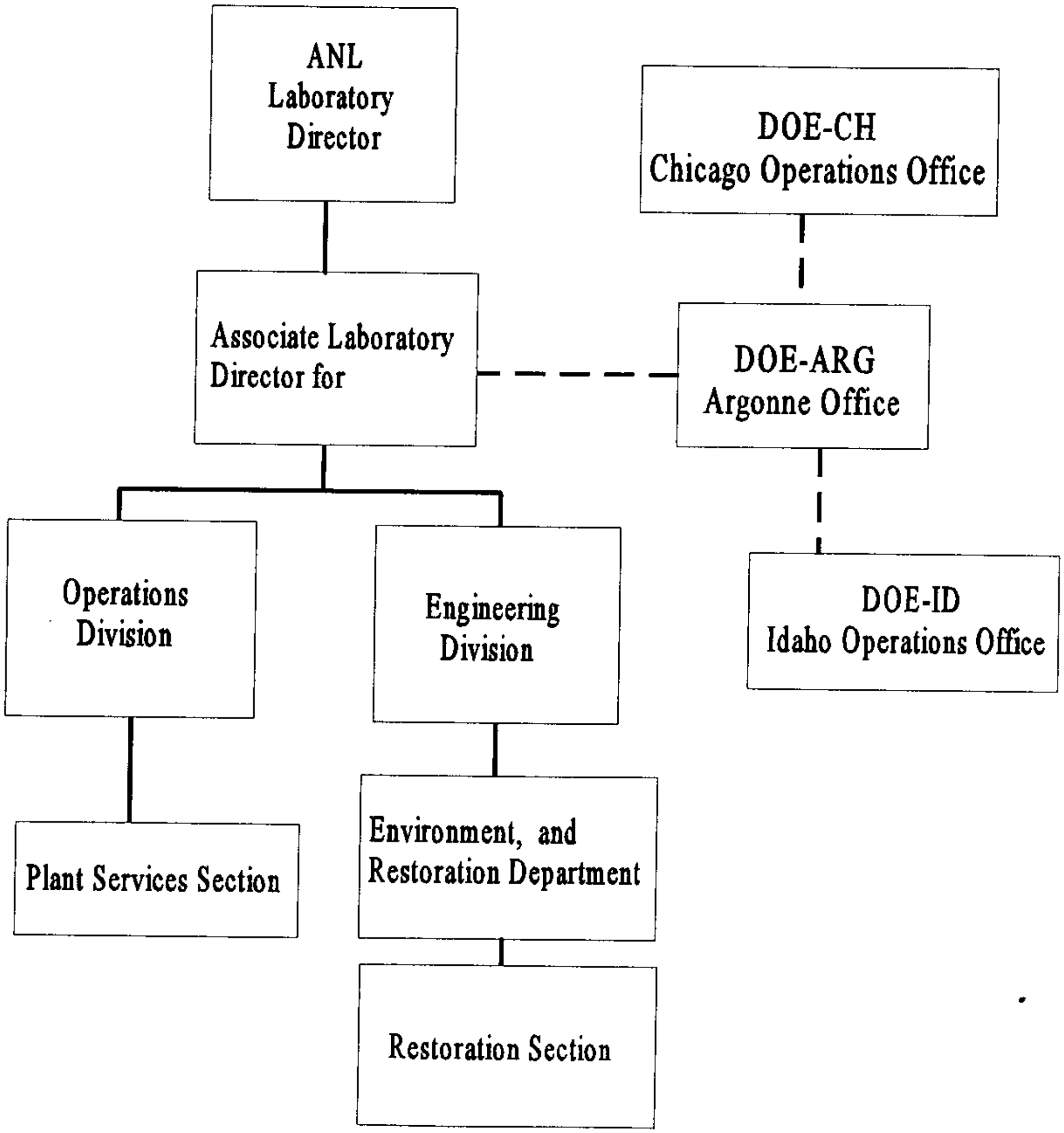
The responsibilities of the EWM organizations involved in groundwater monitoring activities will be as follows:

- The EWM manager has responsibility and authority to approve and ensure application of this program for groundwater monitoring.

- The EWM section is responsible for preparing, revising, and carrying out the QAPjP.

- The EWM section is further responsible for the following:
    - Determining the need for application of groundwater monitoring to specific sources.
    - Reviewing the requirements for groundwater monitoring and how to comply with and implement those requirements of DOE orders, EPA regulations, etc., concerning groundwater monitoring.
    - Preparing and/or reviewing procedures for EWM section activities related to groundwater monitoring.
    - Reviewing and concurring with procedures on groundwater monitoring activities for which ANL-W is responsible but are done by non-EWM section personnel and non-ANL-W contractors.
    - Performing periodic internal audits of all groundwater monitoring activities.

Figure 1. Organizational Structure of ANL-W Groundwater Monitoring Program



- Issuing internal audit reports and corrective action reports of groundwater monitoring activities.
- Independently evaluating and interpreting data, consistent with Section 8 of this QAPjP, related to groundwater monitoring to ensure that environmental releases are within appropriate limits and to ensure that corrective action and reporting is initiated as necessary.
- Maintaining awareness of existing and pending orders, rules, laws, and regulations affecting groundwater monitoring.
- Preparing and issuing reports of groundwater monitoring data to ANL-W management, DOE-CH, and cognizant government agencies.
- Overseeing activities of others who are performing functions affecting the quality of the groundwater monitoring system.
- Controlling ER documents containing any data and records of groundwater releases.
- Ensuring that records of groundwater data measurements are maintained.

2.2 Reactor Program Services Division

2.2.1 Radiation, Fire, Safety (RFS) Section

The RFS section of the RPS Division is responsible for the following:

- Proper review and concurrence on any required Radiation Work Permits.
- Providing a trained health physics (HP) technician when required by a Radiation Work Permit or Safe Work Permit.
- Preparing, issuing, and revising procedures for groundwater monitoring activities performed by HP personnel as needed.
- Proper review of Safe Work Permits as may be required.
- Review and concurrence with any required health and safety plans generated.
- Independent review and evaluation of results.

2.2 ANL-W Analytical Laboratory

The ANL-W Analytical Laboratory (AL) is currently set up to conduct limited environmental sample analysis. If Contract Laboratory Program (CLP) requirements must be

- On a case by case basis, receiving, maintaining chain-of-custody for, and analyzing groundwater monitoring samples according to their own approved QA Plan and procedures.
- Reporting sample results to EWM.
- Assistance in preparation of blind spike and quality control standard samples for use as Quality Assurance/Quality Control (QA/QC) checks for subcontracted laboratories.
- Maintaining a QA Plan and procedures for analytical services associated with groundwater monitoring activities done by the AL.
- Providing assistance to EWM in interpretation of analytical results from subcontracted labs.

2.3 Division Quality Assurance Representative

The Quality Assurance Representative (QAR) of the Reactor Program Services Division (RPS) is responsible for the following:

- Reviewing and concurring with the final version of this QAPjP.
- Providing qualified auditor capabilities as needed to conduct system and performance audits.
- Performing normal activities associated with procurement, variances, nonconformances, Unusual Occurrence Reporting, and corrective actions as related to the ANL-W groundwater monitoring program.
- Performing system and performance audits of subcontracted laboratories as needed.
- Periodically performing audits of all groundwater monitoring activities.
- Performing inspection and surveillance, and witnessing instrument calibrations and testing.
- Issuing audit reports and corrective action reports related to performance of groundwater monitoring activities.
- Reviewing groundwater monitoring procedures, design documents, and procurement documents for inclusion of quality requirements.

2.4 Subcontractor Support

ANL-W will subcontract the services of analytical laboratories to conduct sample analyses of groundwater samples. This subcontracting may be done either directly through ANL-W Procurement or indirectly by using the INEL Sample Management Office (SMO). Services for sample collection may also be subcontracted out to qualified engineering firms. Laboratory responsibilities will be arranged with individual laboratories as they are subcontracted.

Responsibilities common to all labs will be the supplying of sample shuttles or coolers. If sample analysis is required to be conducted by an ANL laboratory, a separate, more specific QAPjP may be prepared to outline their responsibilities and procedures.

3.0 Quality Assurance Objectives

Quality assurance objectives for groundwater monitoring activities include personnel training, proper sampling, reporting, and document control activities, to ensure that accuracy, precision, and representativeness of sample data are of known and acceptable quality. These actions will assure that validated sample results from subsequent years can be accurately compared and used for long term trending analysis. To insure that these actions are meets they will be detailed in either procedures or management reviewed documents. For example training requirements for personnel conducting groundwater actions are outlined in the ANL-W Groundwater Protection Management Program Plan.

The analytes of interest for this QAPjP are listed in Section 7 and Table 7-1, cross--referenced to standard methods and minimum detection limits. These minimum detection limits will be established as contractual requirements with the subcontracted analytical laboratories used.

Where the analytes of interest listed in Table 7-1 are also addressed in the current EPA Contract Laboratory Program (CLP) statements of work for organic and inorganic analysis (EPA, 1988 and EPA, 1989), CLP precision and accuracy criteria will apply. If the analytes of interest are not addressed in the current CLP statements of work, the guidelines for precision and accuracy contained within the reference methods identified in Table 7-1 will apply. All analytical procedures will require the use of units and reporting techniques that are consistent with the standard reference methods listed in Table 7-1 to simplify the comparability of analytical results.

Goals for data representativeness are addressed qualitatively by the specification of sampling frequencies; see Section 5.5 of the WAG-9 Groundwater Monitoring Plan, and Section 3.4.3.4 of the INEL Groundwater Monitoring Plan. Objectives for completeness will require that the guidelines for precision and accuracy discussed above be met for at least 90 percent of the total number of requested determinations. Failure to meet this criterion will be documented as a nonconformance and resolved according to Administrative Procedure AWP-4.7, Deficiency/Nonconformance Reporting.

ANL-W's Analytical Chemistry section has a written QA Plan for the analyses of all internal samples (Analytical Laboratory Quality Assurance Plan (ALQAP), doc. no. W0660-0012-QP, current revision). They also maintain procedures for the analyses conducted. QA programs for subcontracted laboratories will also be reviewed and approved before sample shipment against the criteria presented in this QAPjP.

3.1 Personnel Training Requirements

Any ANL-W technical staff, assigned QA staff, inspection personnel, or quality program auditors that will be working on or with the ANL-W groundwater monitoring program will be trained, qualified, certified (where appropriate), and periodically retrained to maintain proficiency in compliance. At a minimum technical staff evaluating groundwater data should be a "Qualified Ground-Water Scientist" as defined in section 6.8.2 of the ANL-W Groundwater Protection Management Plan. Training activities will be conducted and documented, and will address the specific requirements of this QAPjP and the implementing procedures referenced herein, to the extent appropriate for the work assignments of individual personnel. Training will include an appropriate required reading program. Subcontractor training and qualification requirements will be defined in applicable procurement documents. All training records specific to ANL-W groundwater monitoring program activities will be retained as QA records as described in Section 14.

The Project Manager will hold an opening meeting before initiating work on a project to familiarize personnel with the overall goals and requirements of the project. Meeting topics will be documented on an agenda prepared by the Project or Task Manager, and will include the following minimum items:

- project goals;
- unique project requirements;
- project organization and, to the extent known, personnel assignments;
- procurement control/subcontracting considerations;
- project schedule;
- specific quality concerns (Note: If a project-specific QA plan will be required, a separate QA training session will be held);
- health and safety concerns;
- technical requirements;
- budgetary considerations; and
- useful information learned from previous projects of the same type or for the same organization.

Questions and comments will be solicited from the attendees; unresolved questions will be identified as action items and assigned to responsible individuals for action and resolution. Meeting attendance and discussion items will be documented as directed by the Project Manager. Attendees will include, as appropriate for each project:

- Project Manager,
- Technical Staff,
- Laborers

- Project Health and Safety Officer or designated representative.

The meeting agenda and attendance documentation will be retained in the project QA records, and will be distributed to all attendees as well as to all personnel subsequently assigned to the project.

4.0 Sampling Procedures

Information has been written into the WAG-9 and INEL groundwater monitoring plans that delineate the sample size, frequency, type of analysis, and methods necessary to produce accurate, precise, and randomly representative data. If the INEL SMO is used then their procedures for analytical quality, internal audits, and data validation will be used instead of those outlined in this QAPjP. Procedures will be prepared to address periodic internal audits, internal QC checks, and performance and system audits. Procedures are updated as changes in the program occur.

4.1 Documentation Requirements

The chronology of all field activities will be documented in permanently bound laboratory notebooks following INEL Environmental Investigation Procedure (EIP) EIP-18 "Field Log Books." One consecutively numbered notebook will be assigned for each year. Notebooks will be issued and maintained by the EWM Section. Whenever technical procedures are invoked that reference the use of other forms, the items included on such forms will be considered minimum requirements to be addressed in the bound notebooks in conjunction with the use of the forms. All notebook entries will be in indelible black or blue ink. All corrections will be made by drawing a single line through the entry in question; all corrections will be dated and initialed.

4.2 Sample Identification and Frequency

Samples will be identified and sealed using standard identification labels and seals, immediately following sample collection. An example of each is shown in Figure 2. Samples suspected of containing radioactivity above background will be identified, packaged, and transported according to Chapter 4 of the ANL-W Radiation Control Manual. Sample numbers will be assigned according to the scheme shown below.

> ANL -xxx(sequential number by samples, obtained from the EWM COC logbook before going into the field) -yy(current year)

Figure 2. Sample Labels and COC Seal

ANL-W GROUND WATER MONITORING - FY 1995 # 10

SAMPLE ID: TIME:
DATE(ddmmmyy): SAMPLER:
LOCATION: DEPTH:
ANALYSIS:

FIELD MEASUREMENT/HAZARDS/PRESERVATION:

ENVIRONMENTAL SAMPLING SUPPLY

LOT # 0104901F
SAMPLE ID

SAMPLED BY	DATE
	TIME
LOCATION	PRESERVATIVE
ANALYSIS	CLIENT

9601 San Leandro Street, Oakland, California 94603
(510) 562-4988 (800) 233-8425

ANL-W SAMPLE SEAL

Collection DATE/TIME ________________
SAMPLE No. __________ Location _______
SIGNATURE __________ COC No. _______

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If the INEL SMO is used, they will assign sample numbers from their tracking system. This number is formatted as follows:

AGW0 xxxx (a four-digit well/sample identifier) aa (an alphabetical container code related to the type of sample)

Container codes are shown on Table 4-1. A typical example of the standard ANL-W scheme is ANL-023-95. This designates the twenty third sample collected in 1995. An example of the SMO format is AGW02101AM, where 21 relates to the well in the SMO tracking system, 01 designates the first of this type of sample this sampling period, and AM denoting Appendix IX metals.

Table 4-1 includes a listing of alphanumerical container codes for the various types of analyses to be done. Additional sample number designators that may be used for field QC samples are, FB if a field blank, EB if an equipment blank, FD if a field duplicate, and FT if a field triplicate. Since spiked samples or reference samples prepared for performance audit purposes (see Sections 10 and 11) must be submitted blind to the analytical laboratory, they will be numbered as if they were field blanks or equipment blanks. The numbers assigned to all samples will be recorded in the appropriate field log.

4.3 Sample Preservation, Container Preparation, and Shipping

Sample preservation, handling, and shipping will be done according to INEL EIP-10 "Chain-of-Custody, Sample Handling, and Packaging" and the ANL-W site wide requirements. Sample containers and insulated shuttles or coolers will be prepared and supplied to the ANL-W sampling personnel by the laboratory conducting the analysis or preparing spiked samples for performance audit purposes. ANL-W will use the sample preparation types, sample volumes, container requirements, preservation requirements, and holding times as specified in Table 4-1. Samples will be cooled to 4° Centigrade or below before shipment in insulated coolers. Sample shuttles will contain adequate "blue ice" packs to maintain internal temperature of 4° Centigrade or below for the duration of the time required to transport the samples to the appropriate laboratory. Sample shuttles/coolers will contain completed ANL-W Chain-of-Custody forms (see Figure 3, Chain-of-Custody form) and, if provided, sample analysis request forms from the appropriate laboratory. If no sample analysis request form has been provided, the ANL-W Analytical Laboratory Analysis Request form (Figure 4) may be used to show the analysis required for each sample. For samples to be analyzed at the ANL-W lab, the ANL-W Chain-of-Custody form and the ANL-W Analytical Sample Record form (Figure 4) will be used. For samples to be analyzed at the ANL-E lab, the ANL-W Chain-of-Custody form and the ANL-E Analytical Chemistry Laboratory Request For Analysis form (Figure 5) will be used. Radiation survey readings will be noted on ANL-W radiation tags according to the ANL-W Radiation Control Manual. Tags will be affixed to individual samples if the survey is above background levels. Shuttles/coolers will be sealed, by EWM personnel, with a tamper-proof seal and clear plastic tape before releasing to the shipper.

Table 4-1 Sample analysis container codes, containers, handling and preservation, and holding time requirements

Analysis (method)	Container Code	Container	Preservation and Handling	Hold Time
		Appendix IX		
Volatiles (8240)	AV	3, 40 ml amber glass vials w/ teflon lined septum lids	HCl or H_2SO_4 to pH < 2 Store @ 4° C Fill upwind of equipment exhausts, no headspace permitted	7 days to extraction
Semivolatiles ( )	HN	3, 1 Liter amber glass w/ teflon lined lids	Store @ 4° C Fill upwind of equipment exhausts	7 days to extraction, 30 days after extraction
Organochlorine Pesticides/ PCB's ( )	FF	3, 1 Liter amber glass w/ teflon lined lids	Store @ 4° C Fill upwind of equipment exhausts, no headspace	7 days to extraction, 30 days after extraction
Organophosphorous Pesticides ( )	JP	3, 1 Liter amber glass w/ teflon lined lids	Store @ 4° C Fill upwind of equipment exhausts, no headspace	7 days to extraction, 30 days after extraction
Organochlorine Herbicides ( )	UH	1, 1 Liter amber glass w/ teflon lined lids	Store @ 4° C Fill upwind of equipment exhausts	7 days to extraction, 30 days after extraction
Dioxin/Furans (8290)	D9	3, 1 Liter amber glass w/ teflon lined lids	Store @ 4° C Fill upwind of equipment exhausts	7 days to extraction, 30 days after extraction
Metals ( )	AM	2, 1 Liter HDPE plastic	HNO_3 to pH < 2	6 months; except Mercury: 28 days
		Radionuclides		
Isotopes	EH	6, 1 Liter HDPE plastic	HNO_3 to pH < 2	6 months
Gross α/ Gross β/ γ spectrometry	FX	4, 1 Liter HDPE plastic	HNO_3 to pH < 2	6 months
Tritium	R8	2, 1 Liter HDPE plastic	HNO_3 to pH < 2	6 months
Iodine-129	RI	2, 1 Liter amber glass	HNO_3 to pH < 2	6 months
		Other		
Cyanide	C2	1, 1 Liter HDPE plastic	NaOH to pH >12; Store @ 4° C	14 days
Sulfide	S3	1, 1 Liter HDPE plastic	NaOH/ZnHCO to pH > 12	
Nitrate/Chloride/ Sulfate	HF	1, 1 Liter HDPE plastic	Store @ 4° C	28 days
Total Organic Carbon	TT	1, 1 Liter HDPE plastic	Store @ 4° C; H_2SO_4 to pH < 2	28 days
Total Organic Halogens	T1	1, 1 Liter HDPE plastic	Store @ 4° C; H_2SO_4 to pH < 2	14 days
Water Quality Parameters[2]	ND	1, 1 Liter HDPE plastic	Store @ 4° C	14 days

4.4 Sampling Equipment Decontamination

All non-dedicated sampling equipment will be thoroughly cleaned before each sampling event following LITCO Environmental Monitoring Technical Procedure SOP-EM-CM-3.2, "Decontaminating Sampling Equipment." This is done to prevent cross-contamination between samples and to ensure accurate representation of analytes of interest for each sample event. Personnel doing decontamination will wear protective clothing and other safety equipment as directed by the site safety plan, ANL-W Industrial Hygiene, an HP technician, or the program manager. Samplers and sampling tools will be disassembled as necessary and cleaned with water and nonphosphate detergent. They will then be rinsed with organic-free distilled/deionized water. If required by the RFS HP technician, samplers will be bagged and released for radioactive decontamination to be done at ANL-W central decontamination facility. Samplers will be reassembled using clean rubber gloves; all decontaminated samplers and sampling tools will be stored in a clean area pending their next use. All wash and rinse fluids will be transferred to the ANL-W Industrial Waste System for disposal. Any waste deemed radioactive, compressible, and burnable will be transferred to storage bags, drums, or tank trucks at the direction of the cognizant EWM person and the RFS HP.

4.5 Analytical Procedures

All analytical procedures that will be used by the AL or subcontractor laboratories will comply with the reference methods listed in Table 7-1, and will be included in their approved laboratory QAPjP.

4.6 Procedure Variation Requests and Change Control

Variations from established field procedure requirements or the requirements of this plan may be necessary in response to unique circumstances encountered during sampling activities that do not affect the ability of the samples to meet the required performance or quality criteria. All such variations must be documented in the field log book and on a Variation Request Form (Figure 6). Variation requests to this Plan are to be made utilizing procedures AWP 4.3, "Document Management System," and AWP 4.4, "Document Control." The variation request form is to be submitted to the EWM project manager for review and approval. The lead field engineer is authorized to carry out variations based on immediate need, if the EWM project manager is notified within 24 hours of the variation, and the variation request form is forwarded to the EWM project manager for review within two working days. If the variation is unacceptable to any reviewer, the activity will be repeated or other corrective action taken as shown in the "Comments" section of the checklist. All variation request forms for this project will be sequentially numbered.

Figure 3. Sample Chain of Custody Form

ANL-W CHAIN OF CUSTODY RECORD

4257

DATE:	SAMPLE BY: (Print Name)	SIGNATURE	PROCESS:

ANALYTICAL SAMPLE RECORD INCLUDED ☐ NO ☐ YES , FORM # ____

FIELD COMMENTS:

DATE & TIME COLLECTED	LOG NO.	SAMPLE NUMBER	SAMPLE LOCATION	SAMPLE MATRIX	NUMBER OF CONTAINERS	TYPE & AMOUNT OF PRESERVATIVE ADDED	DATE & TIME PRESERVATIVE ADDED	REMARKS

RELINQUISHED BY: (Print Name)	SIGNATURE	ORGANIZATION	DATE	TIME		
RECEIVED BY: (Print Name)	SIGNATURE	ORGANIZATION	DATE	TIME	Y / N	Received with Seal Intact Label(s), Seal(s), COC(s) Agree
RELINQUISHED BY: (Print Name)	SIGNATURE	ORGANIZATION	DATE	TIME		
RECEIVED BY: (Print Name)	SIGNATURE	ORGANIZATION	DATE	TIME	Y / N	Received with Seal Intact Label(s), Seal(s), COC(s) Agree
RELINQUISHED BY: (Print Name)	SIGNATURE	ORGANIZATION	DATE	TIME		
RECEIVED BY: (Print Name)	SIGNATURE	ORGANIZATION	DATE	TIME	Y / N	Received with Seal Intact Label(s), Seal(s), COC(s) Agree

ANL-498(4-93) WHITE-TO ORIGINATOR FROM LAB YELLOW-LABORATORY PINK-ORIGINATOR

Figure 4. ANL-West Analytical Laboratory Analysis Request Form

ANL-WEST ANALYTICAL LABORATORY ANALYSIS REQUEST FORM

Sample Description: ______

Report Results To: ______

Facility: ______ Phone No.: ______ COC No.: ______

Sampled At: ______ Number Of Samples: ______

Sample Classification: ( ) Environmental; ( ) Waste; ( ) R&D; ( ) Process; ( ) Information Only; ( ) Other ______

Analytical Lab Log Number (Assigned by AL): ______

Sample No.	Sample Identification	Date/ Time Taken	Analysis Requested				

RADIATION SURVEY INFORMATION HP Initials ______ Date ______

Alpha ______ Beta ______ Beta/Gamma ______

Samples Delivered To Analytical Laboratory By: ______ Date: ______ Time: ______

Figure 5. ANL-E Analytical Chemistry Laboratory Request For Analysis Form

REQUEST FOR ANALYSIS
Analytical Chemistry Laboratory

			DATE
SUBMITTED BY (Print Name)	DIVISION	LOCATION	PHONE
COST CODE NUMBER	COST CODE AUTHORIZATION (Signature)		
NAME OF PROGRAM/PROJECT SUPPORTING THIS WORK			

REPORT RESULTS TO: (Print Names)	DIVISION	LOCATION	PHONE
	DIVISION	LOCATION	PHONE
	DIVISION	LOCATION	PHONE

It is agreed that publication of the data resulting from this analysis will provide appropriate acknowledgment for the analysts involved.

DESCRIBE ANALYTICAL SERVICE NEEDED: ACCURACY NEEDED:		
SPECIFIC PROCEDURE REQUIRED: ☐ NO ☐ YES	DOCUMENT NO.	REVISION NO.
SAMPLE DESCRIPTION: (Approximate composition) SOLVENT (If in solution):		
RADIOACTIVITY: ☐ NO ☐ YES	TYPE	LEVEL
SPM INTERIM TRANSITION NO.	HEALTH PHYSICS AUTHORIZATION	
POTENTIAL HEALTH HAZARD OR SPECIAL WASTE DISPOSAL (Carcinogenic, toxic, etc.). ☐ NO ☐ YES Describe:		
SAMPLE ORIGIN: (Sample history, source, manufacturer, etc.)		
SPECIAL HANDLING REQUIRED ☐ NO ☐ YES Describe:		
REMARKS: (If more space is necessary, continue on back)		

Submitter's Sample No.	ACL Sample No.

FOR ACL OFFICE USE ONLY

ANALYSTS ASSIGNED:	ESTIMATED HOURS:	DATE REPORTED:

ACL Job No.

ANL-80 (2-88)

4.7 Procurement of Equipment and Services

Any equipment or services acquired for use in groundwater monitoring will be controlled to assure full conformance with specified requirements. When specified in appropriate procurement documents (through technical specifications or a statement of work) a vendor will supply requested QA information for evaluation before initiating activities that may affect monitoring program quality.

Any outside procurement activities will be accomplished according to section 7.2 of the ANL-W Quality Assurance Program.

Figure 6. Variation Request Form

Variation No. ______ (Number to be provided by EWM)

VARIATION REQUEST

(Date of Request)

I. EFFECTIVE PERIOD

This variation is to remain in effect for the period of ...
(Complete period for which variation is required)

II. ANL-W GROUNDWATER MONITORING PLAN/ QUALITY ASSURANCE PROJECT PLAN REQUIREMENT

(State the section, chapter, page, paragraph, and requirement for which the variation is necessary.)

III. JUSTIFICATION FOR VARIATION - ALTERNATE SAFETY MEASURES

(Justify the need for the variation. Explain how the proposed alternate method will provide for the safe and efficient conduct of the operation(s).)

IV. REVIEW OF VARIATION

(A statement of review action and comments, to be provided by ANL-W EWM.)

V. APPROVALS

REQUESTED BY:

____

____
(Supervisor)

REVIEWED BY:

____
(OQA Representative)

____
(Manager, EWSM)

APPROVED BY:

____
(Division Director or Appointed Repr.)

5.0 Sample Custody

Sample custody procedures have been developed for ANL-W and are referred to as Chain-of-Custody procedures. Samples for which results are to be reported to a regulatory agency require the sampler to follow Chain-of-Custody procedures. Chain-of-Custody procedures are also required if samples are taken to prove waste is nonhazardous for shipment off site.

All samples obtained during sampling will be controlled as outlined in ANL-W Administrative Procedure AWP 2.8, "Chain-of-Custody." ANL-W Chain-of-Custody forms (see Figure 3) will be completed for each shipment of samples as described in the procedure. Sample analysis request forms supplied by the analytical laboratory or ANL-W Analytical Sample Record forms (if used) will specifically identify applicable reference methods specified in Table 7-1 as appropriate for each individual sample. Chain-of-Custody forms will be initiated for return of residual samples as required by the laboratory's own Chain-of-Custody procedures. ANL-W analytical laboratory Chain-of-Custody and sample tracking procedures will ensure traceability of analytical results to the original samples through unique internal identification codes that are traceable to unique sample identification numbers as specified in Section 4.2. Approved laboratory Chain-of-Custody and sample tracking procedures will be addressed in individual approved laboratory QAPjPs.

Sample shuttles/coolers will contain completed ANL-W Chain-of-Custody forms and, if provided, sample analysis request forms from the appropriate laboratory. If no sample analysis request form has been provided, the ANL-W Analytical Sample Record form may be marked to show clearly the analysis required for each sample. For samples to be analyzed at the ANL-W lab, the ANL-W Analytical Sample Record form will be used. For samples to be analyzed at the ANL-E lab, the ANL-E Analytical Chemistry Laboratory Request For Analysis form will be used.

Chain-of-Custody procedures for internal ANL-W samples are maintained by the AL section. The procedures require an individual from the analytical section to sign and to certify receipt of that sample into possession of the AL. Date and time of receipt and any remarks are noted on the sheet.

6.0 Calibration Procedures and Frequency

Manufacturers' instructions or ANL-W Administrative Procedure AWP 2.5, "Measuring and Test Equipment" will be used during calibrations of groundwater monitoring equipment. Calibrations of all ANL-W leased or owned measuring and test equipment, whether in existing inventory or purchased, will be controlled by instrument specific procedures (i.e., ESWM Procedure 3.13, "Calibration of 803PS Multi-parameter Data Sonde and Single Parameter Probes,") or as stated in AWP 2.5. Calibration requirements applicable within individual analytical laboratories used are addressed within each approved laboratory QAPjP, and meet the applicable reference methods listed in Table 7-1. Procedures will delineate frequency, responsibility, necessary equipment, and methods.

7.0 Analytical Procedures

Methods of analysis will be those outlined in EPA SW-846, Test Methods for Evaluating Solid Waste: Physical/ Chemical Methods. If no such method is listed for a particular parameter, then the analytical method from Analytical Chemistry Methods Manual will be used. These methods were taken from various collections of methods, such as those from the EPA, National Institute for Occupational Safety and Health (NIOSH), American Society for Testing and Materials (ASTM), and Association of Official Analytical Chemists (AOAC). Table 7-1 cross-references the analytes of interest for current groundwater investigations to the standard reference methods and method detection limits to be established as contractual requirements between ANL-W and the subcontractor laboratories. Constituent limits from 40 CFR 264, Appendix IX are included since they are used for initial sampling of current and any new wells. Individual laboratories' analytical methods will be reviewed against the reference method requirements and will be included in the ANL-W approved laboratory QAPjP.

Table 7-1
Analytical Categories, Analytes of Interest,
Reference Methods and Detection Limit Requirements

Primary Drinking Water Standards
Required Detection Limit

in Methods for the Determination of Organic Compounds in Drinking Water, EPA/600/4-88/039, 1988

Parameter	Method	Water[a], mg/L
Alachlor	505/ 507	0.0002
Aldicarb	531.1	0.0005
Aldicarb sulfoxide	531.1	0.0005
Aldicarb sulfone	531.1	0.0008
Atrazine	505/ 507	0.0001
Benzo (a) pyrene	550.1	0.00002
Carbofuran	531.1	0.0009
Chlordane	505/ 508	0.0002
Dalapon	515.1	0.001
Dibromochloropropane (DBCP)	504	0.00002
Di (2-ethlyhexyl) adipate	525.1	0.0006
Di (2-ethlyhexyl) phthalate	525.1	0.0006
Dinoseb	515.1	0.0002
Diquat	549	0.0004
2,4-D	515.1	0.0001
Endothall	548	0.009
Endrin	505/ 508	0.00001
Ethylene dibromide (EDB)	504	0.00001
Glyphosate	547	0.006
Heptachlor	505/ 508	0.00004
Heptachlor epoxide	505/ 508	0.00002
Hexachlorobenzene	505/ 508	0.0001
Hexachlorocyclopentadiene	505	0.0001
Lindane	505/ 508	0.001
Methoxychlor	505/ 508	0.01
Oxamyl	531.1	0.002
Pentachlorophenol	515.1	0.00004
Picloram	515.1	0.0001
Polychlorinated Biphenyls (PCBs)	505/ 508 (screening)	
[as decachlorobiphenyl]	508A	0.0001
Simazine	505/ 507	0.00007
Toxaphene	505/ 508	0.001
2,3,7,8-TCDD (Dioxin)	1613	0.000000005
2,4,5-TP (Silvex)	515.1	0.0002
Trihalomethanes	501.1/ 501.2	0.1

(sum of bromodichloromethane, bromoform, chloroform, dibromochloromethane)

a Required detection limits from 40 CFR 141.

Table 7-1, Continued

Primary Drinking Water Standards
Required Detection Limit

Parameter	EPA-600/4-79-020, 1979 Method	Water[a], mg/L
Asbestos	TEM	7 MFL
Arsenic	206.2/ 206.3	0.01
Barium	208.1/ 208.2	0.2
Cadmium	213.1/ 213.2	0.005
Chromium	218.1/ 213.2	0.01
Lead	239.1/ 239.2	0.005
Mercury	245.1/ 245.2	0.0002
Nitrate (as N)	353.1/ 353.3	1.0
Nitrite	354.1/ 353/1	
Selenium	270.2/ 270.3	0.005

Methods in Standard Methods for the Examination of Water and Wastewater
(unless otherwise noted)

Radium 226/228	305	5 pCi/L
Cesium 134	ASTM D-2459	10 pCi/L
Iodine 131		1 pCi/L
Strontium 89	303	10 pCi/L
Strontium 90	303	2 pCi/L
Tritium	306	1,000 pCi/L
Gross Alpha	302	15 pCi/L
Gross Beta	302	4 pCi/L

a Required detection limits, from 40 CFR 141.
b TEM = Transmitting Electron Microscope
c MFL = Million Fibers per Liter

Table 7-1, Continued

Secondary Drinking Water Standards

Methods in Standard Methods for the Examination of Water and Wastewater

Parameter	Method[a]	Water[b], mg/L
Aluminum	Inductively Coupled Plasma	0.05
Chloride	Potentiometric	1.0
Color	Platinum/Cobalt	15 units
Copper	Atomic Absorption	1.0
Corrosivity	NA	Noncorrosive
Fluoride	TBD	2.0
Foaming Agents	Methylene Blue	0.5
Iron	Atomic Absorption	0.05
Manganese	Atomic Absorption	0.01
Odor	Consistent Series	3 threshold odor no.
pH	Glass Electrode	6.5 - 8.5
Silver	Inductively Coupled Plasma	0.1
Sulfate	Turbidimetric	250.0
Total Dissolved Solids	Total Residue	500.0
Zinc	Atomic Absorption	5.0

a All methods are referenced by title in "Standard Methods for Examination of Water and Wastewater"

b Maximum Contaminant Level, from 40 CFR 143.

Table 7-1, Continued

Appendix IX Volatile Organics (SW846, EPA Method 8240)
Required Detection Limit

Compound	Water[a], $\mu g/L$
Acetone	100
Acrolein	5
Allyl chloride	100
Benzene	5
Bromodichloromethane	15
Bromoform	25
Carbon disulfide	5
Carbon tetrachloride	5
Chlorobenzene	5
Chloroethane	10
Chloroform	5
Chloroprene	5
Dibromochloromethane	10
Dichlorodifluoromethane	10
cis-1,3-Dichloropropene	5
trans-1,4-Dichloro-2-butene	5
trans-1,3-Dichloropropene	5
1,1-Dichloroethane	5
1,1-Dichloroethylene	5
1,2-Dibromoethane	5
1,2-Dibromo-3-chloropropane	5
1,2-Dichloropropane	5
1,2-Dichloroethane	5
Ethyl benzene	5
Ethyl methacrylate	5
2-Hexanone	50
2-Picoline	10
Methacrylonitrile	5
Methyl bromide	10
Methyl chloride	10
Methyl ethyl ketone	100
Methyl iodide	5
Methyl methacrylate	5
Methylene bromide, Dibromomethane	5
Methylene chloride, Dichloromethane	5
Methyl isobutyl ketone (MEK)	50
Pentachloroethane	5
Propionitrile; Ethyl cyanide	5
2-Picoline	5
Pyridine	5
Styrene	5
Tetrachloroethylene	5

a Values are Practical Quantitation Limits (PQLs) from 40 CFR 264, Appendix IX

Table 7-1, Continued

Appendix IX Volatile Organics (SW846, EPA Method 8240)
Required Detection Limit

Compound	Water[a], μg/L
Toluene	5
Trichloroethylene	5
Trichlorofluoromethane	5
1,1,1,2-Tetrachloroethane	5
1,1,2,2-Tetrachloroethane	5
1,1,1-Trichloroethane	5
1,1,2-Trichloroethane	5
1,2,3-Trichloropropane	5
Vinyl acetate	5
Vinyl chloride	10
Xylene (total)	5

Appendix IX Semivolatiles (SW846, EPA Method 8270)
Required Detection Limit

Compound	Water[a], μg/L
Acenaphthene	10
Acenaphthylene	10
Acetophenone	10
2-Acetylaminofluorene; 2-AAF	10
Aldrin	10
4-Aminobiphenyl	10
alpha, alpha-Dimethylphenethylamine	10
Aniline	10
Anthracene	10
Aramite	20
Benzo[a]anthracene	10
Benzo[b]fluoranthene	10
Benzo[k]fluoranthene	10
Benzo[ghi]perylene	10
Benzo[a]pyrene	10
Benzyl alcohol	20
Bis(2-chloroethoxy)methane	10
Bis(2-chloroethyl)ether	10
Bis(2-chloro-1-methylethyl) ether	10
Bis(2-ethylhexyl) phthalate	10
4-Bromophenyl phenyl ether	10
Butyl benzyl phthalate	10
p-Chloroaniline	20
Chlorobenzilate	10

a Values are Practical Quantitation Limits (PQLs) from 40 CFR 264, Appendix IX

Table 7-1, Continued

Appendix IX Semivolatile Organics (SW846, EPA Method 8270)
Required Detection Limit

Compound	Water[a], $\mu g/L$
p-Chloro-m-cresol	20
2-Chloronaphthalene	10
2-Chlorophenol	10
4-Chlorophenyl phenyl ether	10
Chrysene	10
m-Cresol	10
o-Cresol	10
p-Cresol	10
4,4'-DDD	10
4,4'-DDE	10
4,4'-DDT	10
Diallate	10
Dibenz[a,h]anthracene	10
Dibenzofuran	10
1,2-Dibromo-3-chloropropane (DBCP)	10
Di-n-butyl phthalate	10
m-Dichlorobenzene	10
o-Dichlorobenzene	10
p-Dichlorobenzene	10
3,3'-Dichlorobenzidine	20
2,4-Dichlorophenol	10
2,6-Dichlorophenol	10
Dieldrin	10
Diethyl phthalate	10
0,0-Diethyl 0-2-pyrazinyl phosphorothioate	10
Dimethoate	10
P-(Dimethylamino)azobenzene	10
7,12-Dimethylbenz[a]anthracene	10
3,3'-Dimethylbenzidine	10
2,4-Dimethylphenol	10
Dimethyl phthalate	10
m-Dinitrobenzene	10
4,6-Dinitro-o-cresol	50
2,4-Dinitrophenol	50
2,4-Dinitrotoluene	10
2,6-Dinitrotoluene	10
Dinoseb (2-sec-Butyl-4,6-dinitrophenol)	10
Di-n-octyl phthalate	10
Diphenylamine	10
Disulfoton	10
Endosulfon sulfate	10
Endrin aldehyde	10

a Values are Practical Quantitation Limits (PQLs) from 40 CFR 264, Appendix IX

Table 7-1, Continued

Appendix IX Semivolatile Organics (SW846, EPA Method 8270)
Required Detection Limit

Compound	Water[a], μg/L
Ethyl methanesulfonate	10
Famphur	10
Fluoranthene	10
Fluorene	10
Heptachlor	10
Heptachlor epoxide	10
Hexachlorobenzene	10
Hexachlorobutadiene	10
Hexachlorocyclopentadiene	10
Hexachloroethane	10
Hexachlorophene	10
Hexachloropropene	10
Indeno(1,2,3-cd)pyrene	10
Isodrin	10
Isophorone	10
Isosafrole	10
Kepone	10
Methapyrilene	10
Methoxychlor	10
Methyl methansulfonate	10
3-Methylcholanthrene	10
2-Methylnaphthalene	10
Methyl parathion	10
Naphthalene	10
1,4-Naphthoquinone	10
1-Naphthylamine	10
2-Naphthylamine	10
m-Nitroaniline	50
o-Nitroaniline	50
p-Nitroaniline	50
Nitrobenzene	10
o-Nitrophenol	10
p-Nitrophenol	50
4-Nitroquinoline 1 -oxide	10
N-Nitrosodi-n-butylamine	10
N-Nitrosodiethylamine	10
N-Nitrosodimethylamine	10
N-Nitrosodiphenylamine	10
N-Nitrosodipropylamine	10
N-Nitrosomethylethylamine	10
N-Nitrosomorpholine	10
N-Nitrosopiperidine	10

a Values are Practical Quantitation Limits (PQLs) from 40 CFR 264, Appendix IX

Table 7-1, Continued

Appendix IX Semivolatile Organics (SW846, EPA Method 8270)
Required Detection Limit

Compound	Water[a], μg/L
N-Nitrosopyrrolidine	10
5-Nitro-o-toluidine	10
Parathion	10
Pentachlorobenzene	10
Pentachloroethane	10
Pentachloronitrobenzene	10
Pentachlorophenol	50
Phenacetin	10
Phenanthrene	10
Phenol	10
p-Phenylenediamine	10
Phorate	10
2-Picoline	10
Pronamide	10
Pyrene	10
Pyridine	20
Safrole	10
1,2,4,5-Tetrachlorobenzene	10
2,3,4,6-Tetrachlorophenol	10
Tetraethyldithiopyrophosphate (Sulftepp)	10
o-Toluidine	10
1,2,4-Trichlorobenzene	10
2,4,5-Trichlorophenol	10
2,4,6-Trichlorophenol	10
0,0,0-Triethyl phosphorothioate	10
sym-Trinitrobenzene	10

Appendix IX Organophosphorus Pesticides (SW846, EPA Method 8140)
Required Detection Limit

Compound	Water[a], μg/L
Dimethoate	10
Disulfoton	10
Famphur	10
Methyl parathion	10
Parathion	10
Phorate	10
Pronamide	10
Tetraethyl dithiopyrophosphate	10

a Values are Practical Quantitation Limits (PQLs) from 40 CFR 264, Appendix IX

Table 7-1, Continued

Appendix IX Alcohols and Other (SW846, EPA Method 8015; EPA, 1986)
Required Detection Limit

Compound	Water[a], μg/L
Acetonitrile; methyl cyanide	100
1,4-Dioxane	150
Isobutyl alcohol	50

Appendix IX Pesticides/ PCBs (SW846, EPA Method 8080; EPA, 1986)
Required Detection Limit

Compound	Water[a], μg/L
4,4'-DDT	0.1
4,4'-DDE	0.05
4,4'-DDD	0.1
Aldrin	0.05
alpha-BHC	0.05
beta-BHC	0.05
Chlordane	0.1
Chloroprene	5
Chlorobenzilate	5
delta-BHC	0.1
Diallate	10
Dieldrin	0.05
Endosulfan I	0.1
Endosulfan sulfate	0.5
Endosulfan II	0.05
Endrin aldehyde	0.2
Endrin	0.1
Endrin Ketone	10
gamma-BHC; Lindane	0.05
Heptachlor	0.05
Isodrin	10
Kepone	10
Heptachlor epoxide	1
Methoxychlor	2
PCB 1016	0.5
PCB 1242	0.5
PCB 1232	0.5
PCB 1221	0.5
PCB 1248	0.5
PCB 1260	1
PCB 1254	1
Toxaphene	2

a Values are Practical Quantitation Limits (PQLs) from 40 CFR 264, Appendix IX

Table 7-1, Continued

Appendix IX Inorganics
Required Detection Limit

Compound	EPA Method(SW846)	Water[a], mg/L
Aluminum*	6010	0.2
Antimony	6010	0.3
Arsenic	6010/7060	0.5/ 0.01
Barium	6010	0.02
Beryllium	6010	0.003
Cadmium	6010	0.04
Calcium*	6010	5.0
Chromium	6010	0.07
Cobalt	6010	0.07
Copper	6010	0.06
Cyanide	9010	0.04
Iron*	6010	0.05
Lead	6010/7421	0.04/ 0.003
Magnesium*	6010	5.0
Manganese*	6010	0.015
Mercury	7470	0.002
Nickel	6010	0.05
Potassium	6070	5.0
Selenium	6010/7740	0.75/ 0.02
Silver	6010	0.07
Sodium	6010	5.0
Sulfide	9030	10
Thallium	6010/7841	0.4/ 0.01
Tin	7870	8.0
Vanadium	6010	0.08
Zinc	6010	0.02

a Values are Practical Quanitiation Limits (PQLs) from 40 CFR 264, Appendix IX.
* Non Appendix IX constituents to be analyzed with other metals.

Table 7-1, Continued

Radionuclide Parameters
Required Detection Limit

Isotope	Method[a]	Water[b], pCi/L
Americium 241	907	0.5
Antimony 125	901.1	10
Cerium 144	901.1	10
Cesium 134	901.1	10
Cesium 137	901.1	10
Cobalt 58	901.1	10
Cobalt 60	901.1	10
Eurpoium 152	901.1	10
Eurpoium 154	901.1	10
Iodine 129	901.1	10
Neptunium	907	0.5
Plutonium 238	907	0.5
Plutonium 239	907	0.5
Plutonium 240/241	907	0.5
Rhodium 106	901.1	10
Ruthenium 103	901.1	10
Ruthenium 106	901.1	10
Strontium 90	905	1
Tritium	906.0	500
Uranium 234	907	1
Uranium 235	907	1
Uranium 238	907	1
Yttrium 90	905	1

Appendix IX Dioxins/Furans (SW846, EPA Method 8290)
Detection Limit Required

Compound (Total)	Water[a], $\mu g/L$
Tetrachlorodibenzodioxin (TCDD)	0.005
Pentachlorodibenzodioxin (PeCDD)	0.01
Hexachlorodibenzodioxin (HxCDD)	0.01
Heptachlorodibenzodioxin (HpCDD)	0.001
Octachlorodibenzodioxin (OCDD)	0.01
Tetrachlorodibenzofuran (TCDF)	0.01
Pentachlorodibenzofuran (PeCFD)	0.01
Hexachlorodibenzofuran (HxCDF)	0.01
Heptachlorodibenzofuran (HpCDF)	0.01
Octachlorodibenzofuran (OCDF)	0.01

a From Prescribed Procedures for the Measurement of Radioactivity in Drinking Water (EPA 600/4-80-032), EPA, 1982.

b Values are Practical Quanitation Limits (PQLs) from 40 CFR 264, Appendix IX.

Table 7-1, Continued

INEL Groundwater Monitoring Analysis
Required Detection Limit

Parameter	Method	Water[a], mg/L
Chlorobenzene	SW 8240	5
Chloroform	SW 8240	5
1,1-Dichloroethane	SW 8240	5
1,2-Dichloroethane	SW 8240	5
1,1-Dichloroethylene	SW 8240	5
1,2-trans-Dichloroethylene		
Methylene chloride	SW 8240	10
Phenol		
Tetrachloroethylene	SW 8240	5
1,1,1-Trichloroethane	SW 8240	5
1,1,2-Trichloroethane	SW 8240	5
Trichloroethylene	SW 8240	5
Arsenic	SW[3] 6010	0.5
Barium	SW 6010	0.02
Bicarbonate	SM 403 (w/alkalinity)	1.0
Calcium	SW 6010	5.0
Carbonate	SM 403 (w/alkalinity)	1.0
Chloride	300.0[1] or SM[2] 407	0.5
Chromium	SW 6010	0.07
Copper	SW 6010	0.06
Fluoride		
Iron	SW 6010 or 200.7/236.1/236.2	0.1/0.01
Lead	SW 6010	0.04
Magnesium	SW 6010	5.0
Mercury	SW 6010	0.002
Nitrate	300.0	0.1
Nitrate as N		
Potassium	SW 6070	5.0
Selenium	SW 6010	0.75
Silver	SW 6010	0.07
Sodium	SW 6010	5.0
Sulfate	300.0 or SM 426	0.2
Thallium	SW 6010	0.4
Vanadium	SW 6010	0.08
Zinc	SW 6010	0.02

1 200 and 300 series methods in EPA-600/4-79-020, 1979
2 SM = Standard Methods for the Examination of Water and Wastewater
3 SW = Test Methods for Evaluating Solid Waste; EPA, 1986
4 Prescribed Procedures for the Measurement of Radioactivity in Drinking Water (EPA 600/4-80-032), (EPA, 1982).

Table 7-1, Continued

INEL Groundwater Monitoring Analysis
Required Detection Limit

Parameter	Method	Water[a], mg/L
pH	SW 9040/9045	0.5 - 14.0
Specific Conductance	EPA 120.1	N/A
Total Alkalinity	EPA 510.1	5
Total Dissolved Solids	EPA 160.1	50.0
Total Organic Carbon (TOC)	415.2/SW 9060	1.0/1.0
Total Organic Halides (TOX)	450.1	0.005
Americium 241	907	0.5 pCi/L
Cobalt 60	901.1	10.0 pCi/L
Cesium 137	901.1	10.0 pCi/L
Neptunium 237	907	0.5 pCi/L
Strontium 90	905	1.0 pCi/L
Tritium	906.0[4]	500.0 pCi/L
Uranium 238	907	1.0 pCi/L
Gross Alpha	SW 9310	10.0 pCi/L
Gross Beta	SW 9310	10.0 pCi/L

1 200 and 300 series methods in EPA-600/4-79-020, 1979
2 SM = Standard Methods for the Examination of Water and Wastewater
3 SW = Test Methods for Evaluating Solid Waste; EPA, 1986
4 Prescribed Procedures for the Measurement of Radioactivity in Drinking Water (EPA 600/4-80-032), (EPA, 1982).

Table 7-1, Continued

Toxicity Characteristic Leach Procedure
(40 CFR 261.)

Compound	TCLP Limit mg/L
Arsenic	0.5
Barium	0.02
Cadmium	0.04
Chromium	0.07
Lead	0.04
Mercury	0.002
Selenium	0.75
Silver	0.07
Benzene	0.005
Carbon tetrachloride	0.005
Chlordane	0.0001
Chlorobenzene	0.005
Chloroform	0.005
o-Cresol	0.01
m-Cresol	0.01
p-Cresol	0.01
Cresol	0.01
2,4-D	0.01
1,4-Dichlorobezene	0.01
1,2-Dichloroethane	0.005
1,1-Dichloroethylene	0.005
2,4-Dinitrotoluene	0.01
Endrin	0.0001
Heptachlor (and Heptachlor epoxide)	0.01
Hexachlorobenzene	0.01
Hexachlorobutadiene	0.01
Hexachloroethane	0.01
Lindane	0.00005
Methoxychlor	0.01
Methyl ethyl ketone	0.1
Nitrobenzene	0.01
Pentachlorophenol	0.05
Pyridine	0.01
Tetrachloroethylene	0.005
Toxaphene	0.002
Trichloroethylene	0.005
2,4,5-Trichlorophenol	0.01
2,4,6-Trichlorophenol	0.01
2,4,5-TP (Silvex)	0.002
Vinyl chloride	0.01

Table 7-1, Continued

PCBs Analysis (SW846, EPA Method 8080; EPA, 1986)
Required Detection Limit

Compound (Total)	Water, $\mu g/L$
PCB 1016	0.5
PCB 1242	0.5
PCB 1232	0.5
PCB 1221	0.5
PCB 1248	0.5
PCB 1260	1
PCB 1254	1

a Values are Threshold Limit Concnetrations representing the Toxicity Characteristic limit multiplied by a factor of 20.

Table 7-1, Continued

Volatile Organics Analyses (SW846, EPA Method 8240; EPA, 1986)
Required Detection Limit

Compound	Wate[a], $\mu g/L$
Acetone	100
Benzene	5
Bromoform	5
Bromodichloromethane	5
Bromomethane	10
2-Butanone	100
Carbon Disulfide	5
Carbon Tetrachloride	5
Chlorobenzene	5
Chloroethane	10
Chloroform	5
Chloromethane	10
Dibromochloromethane	5
1,1-Dichloroethene	5
1,1-Dichloroethane	5
1,2-Dichloroethene (total)	5
1,2-Dichloroethane	5
1,2-Dichloropropane	5
cis-1,3-Dichloropropene	5
trans-1 ,3-Dichloropropene	5
Ethyl Benzene	5
2-Hexanone	50
Methylene Chloride	100
4-Methyl-2-pentanone	50
Tetrachloroethene	5
1,1,2,2-Tetrachloroethane	5
Trichloroethene	5
1,1,1 - Trichloroethane	5
1,1,2 - Trichloroethane	5
Toluene	5
Styrene	5
Vinyl Acetate	50
Vinyl Chloride	10
Xylenes (total)	5

Petroleum Hydrocarbons (EPA Modified 8015; EPA, 1 986)
Required Detection Limit

Compound	Water[a], $\mu g/L$
Kerosene	500

a Values are Contractually Required Detection Limits (CRDLs)

Table 7-1, Continued

Semivolatile Organic Analysis (SW846, EPA Method 8270, EPA 1986)
Required Detection Limit

Compound (Total)	Water[a], $\mu g/L$
Acenaphthene	50
Acenaphthylene	10
Anthracene	10
Benzoic acid	50
Benzo(a)anthracene	10
Benzo(b)fluoranthene	10
Benzo(k)fluoranthene	10
Benzo(a)pyrene	10
Benzo(g,h,i)perylene	10
Benzyl alcohol	20
Dibenz(a,h)anthracene	10
Butylbenzylphthalate	10
Di-n-butylphthalate	10
4-Bromophenyl-phenylether	10
bis (2-Chloroethyl) ether	10
bis(2-Chloroethoxy) methane	10
bis (2-Chloroisopropyl) ether	10
4-Chloroaniline	20
(para-chloro-meta-cresol) 4-Chloro-3-methylphenol	20
4-Chlorophenyl-phenyl ether	10
2-Chloronaphthalene	10
2-Chlorophenol	10
Chrysene	10
Dibenzofuran	10
Diethylphthalate	10
Dimethylphthalate	10
1,3-Dichlorobenzene	10
1,4-Dichlorobenzene	10
1,2-Dichlorobenzene	10
3,3'-Dichlorobenzidine	20
2,4-Dichlorophenol	10
2,4-Dimethylphenol	10
2,4-Dinitrophenol	10
2,4-Dinitrotoluene	10
2,6-Dinitrotoluene	10
4,6-Dinitro-2-methylphenol	50
bis (2-Ethylhexyl) phthalate	10

a Values are Contractually Required Detection Limits (CRDLs)

Table 7-1, Continued

Semivolatile Organic Analysis (SW846, EPA Method 8270, EPA 1986)
Required Detection Limit

Compound (Total)	Water[a], $\mu g/L$
Fluoranthene	10
Fluorene	10
Hexachlorobenzene	10
Hexachlorobutadiene	10
Hexachlorocyclopentadiene	10
Hexachloroethane	10
Indeno(1,2,3-cd)pyrene	10
Isophorone	10
2-Methylnaphthalene	10
2-Methylphenol	10
4-Methylphenol	10
Naphthalene	10
Nitrobenzene	10
N-Nitroso-di-n-dipropylamine	10
2-Nitroaniline	50
3-Nitroaniline	10
2-Nitrophenol	10
4-Nitrophenol	50
4-Nitroaniline	20
N-nitrosodiphenylamjne	10
Di-n-octylphthalate	10
Pentachlorophenol	50
Phenanthrene	10
Phenol	10
Pyrene	10
1,2,4-Trichlorobenzene	10
2,4,5-Trichlorophenol	10
2,4,6-Trichlorophenol	10

a Values are Contractually Required Detection Limits (CRDLs)

Table 7-1, Continued

Miscellaneous Analysis

Parameter	Method	Water[a], mg/L
Chloride	SM 407	0.2
Iron	SM 315	0.05
Manganese	SM 319	0.01
Phenols	SM 510	0.05
Sodium	SM 325	0.2
Sulfate	SM 426	0.2
pH	SM 423/ EPA 150.1	NA
Specific Conductance	EPA 205	NA
Total Organic Carbon	EPA 9060	0.01
Total Organic Halogen	EPA 9020	0.05
Total Coliform Bacteria	MTF/ MF	0 colonies
pH	SW846, 9045	NA
EP-Toxicity	SW846, 1310	NA
Acid Digestion Procedure	SW846, 3050	NA
Arsenic	SM 307	0.01
Barium	SM 308	0.2
Cadmium	SM 310	0.005
Chromium	SM 312	0.01
Lead	SM 316	0.005
Mercury	SM 320	0.0002
Nickel	SM 321	0.04
Selenium	SM 323	0.005
Silver	SM 324	0.01
Fluoride (water)	SM 413/ EPA 340.2	0.1
Fluoride (soil)	ASA No.9, 26-4.5	N/A

a All values are Contractually Required Detection Limits (CRDLs)
SM = Standard Methods for the Examination of Water and Wastewater, current revision.
200 and 300 series methods in EPA-600/4-79-020, 1979.
MTF/MF = Membrane / Membrane Filtration
SW846 = Test Methods for Evaluating Solid Waste November 1986.

8.0 Data Reduction, Validation, and Reporting

Data reduction, validation, and reporting are necessary to ensure that only data of sufficient quality will be used for decision making purposes. Data that is inaccurate, imprecise, or unrepresentative (outliers) will be flagged and reported as such, and not used to make decisions.

8.1 Minimum Requirements for Analytical Data Packages

Analytical data packages will include the following:

- Sample receipt and tracking documentation, including identification of the organization and individuals performing the analysis, names and signatures of the responsible analysts, sample holding time requirements, references to applicable Chain-of-Custody procedures, and dates of sample receipt, extraction, and analysis.

- Instrument calibration documentation, including equipment type and model, with continuing calibration data for the period in which the analyses were performed.

- QC data, as appropriate for the methods used, including matrix spike/matrix spike duplicate data, recovery percentages, precision data, laboratory blank data, and identification of any non-conformance that may have affected the laboratory's measurement system while in the analyses were performed.

- A limitation and validation report, including a brief narrative summary, a review of the raw data and reduced data, reduction formulas or algorithms, and identification of data outliers or deficiencies.

For organic and inorganic analytes included in the current CLP statements of work (EPA, 1988A and EPA, 1989), data will be reported meeting CLP format and content requirements, and will include supporting information such as initial calibration data, reconstructed ion chromatographs, spectrograms, laboratory traffic reports, and raw data. In all cases however, all data packages for all analytes will be reviewed and approved by the analytical laboratory's QA manager before submittal to ANL-W for review and validation, as discussed in Sections 8.2 through 8.6 below. The requirements of this section will be included in laboratory procurement documents according to the requirements of Section 1.6.

8.2 General Validation Requirements

All groundwater data will be validated to Level A protocol as outlined in the current revision of LITCO Environmental Technical Procedure TPR-79, "Levels of Analytical Method Data Validation." Laboratory data validation will require review of the data packages from each sample delivery group to ensure that the laboratory has met all contractual requirements, applicable reference method requirements, and the data quality objectives discussed in Section 3 above. A sample delivery group may consist of a batch of samples delivered to the laboratory on a single day or within a single week. Validation exercises will be documented in report format, which will be subjected to a final review by a senior analytical chemist and the QAR before inclusion in a final report.

Section 12.0 discusses procedures for the general evaluation of precision, accuracy, and completeness of measurement data. Applicable procedures will specify parameters used regularly to evaluate precision, accuracy, representativeness, and completeness of specific analytical measurement data. All groundwater monitoring and measurement data will be routinely assessed. A QAPjP for the Chemical Analysis of Environmental Samples addresses routine assessment of the precision and accuracy of analytical data in the ANL-W AL. Subcontracted laboratories will be required to include similar assessments in their QAPjPs. The validation review done for each data package will specifically address such areas as Chain-of-Custody, sample preparation, instrument calibration and tuning, compound identification, QC, and general data evaluation. EWM will devise worksheets with the appropriate conversion factors to reduce data reported by the labs. Descriptions of data reduction will be kept on file in the EWM central files and updated as changes occur. Calculations are to be checked by hand calculation by an environmental or waste management engineer, to confirm correctness, before submittal of any final reports to DOE or the regulatory agencies.

The narrative summary will be reviewed with specific emphasis on the following items:

- Specific problems associated with the sample analyses, as identified in the narrative.
- Chain-of-Custody records for all samples, emphasizing identification, sample dates, sample shipping and receipt dates, and required sample holding times, and a cross-check against the field records where appropriate.
- Completeness of the data package, as necessary to meet the requirements of Section 8.1 and to assess the data adequately.

8.3 Inorganics Analyses

Inorganics analyses will be reviewed to ensure the following criteria are met according to EG&G ERP SOP-12.1.5, "Inorganic Data Validation":

- Holding Times and Preservation Requirements
- Calibration
- Blanks
- ICP Interference Check Samples (ICS)
- Laboratory Control Sample (LCS)
- Duplicate and Triplicate Sample Analysis
- Matrix Spike Sample Analysis
- Furnace Atomic Absorption Quality Control
- ICP Serial Dilution
- Sample Results Verification
- Field Duplicates and Triplicates
- Overall Data Assessment and Corrective Action

8.4 Volatile and Semivolatile Organics Analyses

All organics analyses will be reviewed to ensure the following criteria are met according to EG&G ERP SOP-12.1.3, "Validation of Volatile and Semivolatile Organic Gas Chromatography/Mass Spectrometry Data" and SOP-12.1.4, "Validation of Gas Chromatographic Data":

- Holding Times
- Gas Chromatograph/Mass Spectrometer (GC/MS) Tuning
- Calibration
- Blanks
- Surrogate Recovery
- Matrix Spike/Matrix Spike Duplicate
- Field Duplicates and Triplicates
- Internal Standards Performance
- TCL Compound Identification
- Compound Quantitation and Reported Detection Limits
- Tentatively Identified Compounds (TIC)
- System Performance
- Overall Data Assessment and Corrective Action

8.5 Pesticide/PCB Analyses

Procedures have yet to be completed for review of pesticide/PCB data. The following sections outline the general criteria to be used for review of this type of data to a Level A.

8.5.1 Holding Times and Preservation Requirements

Chain-of-Custody forms will be reviewed to decide sampling dates and the dates of analysis and extraction to verify that all holding times are within method requirements. Holding times and preservation criteria will be as defined in Table 4-1.

8.5.2 Pesticides Instrument Performance

The following criteria will be checked:

- DDT retention time must be greater than 12 minutes on packed columns (except OV-1 and OV-101).
- For each GC column used to analyze samples, the laboratory must report run time (RT) window data on the Pesticide/PCB Standards Summary.
- The total percent breakdown for either DDT or endrin may not exceed 20 percent.
- The raw data will be checked to verify that the percent difference in retention time for dibutylchlorendate in all samples is less than or equal to 2.0 percent for packed column analysis, less than or equal to 0.3 percent for capillary column analysis, and less than or equal to 1.5 percent for wide-bore capillary column analysis on the appropriate report form.

8.5.3 Calibration

The initial calibration data will be evaluated as follows:

- Raw data will be inspected and compared to the pesticide evaluation standards summary.
- Percent RSDs and calibration factors will be recalculated for aldrin, endrin, 4,4'-DDT, and dibutylchlorendate at the three calibration concentrations.

- The percent RSD for the calibration factor for each specific pesticide/PCB will be verified to be less than or equal to 10 percent for each 72-hour sequence.
- A three-point calibration must be reported if toxaphene or if any of the DDT series were identified and quantitated in any sample.

Continuing calibration data will be evaluated as follows:

- Verify whether the standard was used as a quantitation standard or as a confirmation standard.
- Check the percent difference for the quantitation standards for approximately 10 percent of the reported values.

8.5.4 Blanks

All blank data will be reviewed (including the raw data) to verify that no contamination exists. The method blank analysis will be verified to contain less than the method specific detection limits of any pesticide, PCB, or interfering peak. A method blank must be used for each GC system used in the analysis and for each extraction batch, per matrix and per concentration level. To be considered valid, reported results for any compound must be greater than five times the amount detected in the blank.

8.5.5 Surrogate Recovery

Reported surrogate recoveries will be checked against the raw data. Recoveries will be checked for possible interferences if they do not fall within specified limits.

8.5.6 Matrix Spike/Matrix Spike Duplicate

Matrix Spike/Matrix Spike Duplicate recovery will be reviewed against the raw data and compared with the method specific recovery limits.

8.5.7 Field Duplicates and Triplicates

Field duplicates and triplicates will be identified based on review of Chain-of-Custody and field sampling records. The reported results will be compared for each sample and the RPD calculated to determine the overall precision of the field sampling and laboratory analytical activities.

8.5.8 Compound Identification

The reported compounds will be reviewed and compared with the raw data to ensure that positive results are properly confirmed. The review will consist of examining retention times and windows, and verifying correctness of compounds listed as "not detected." Positive identifications will be verified by confirmation column analysis. For chlordane, toxaphene, and PCBs, retention times and relative peak height ratios of major component peaks will be compared against appropriate standard chromatograms. GC/MS confirmation will be done for pesticide/PCB concentrations if the final sample extract concentration exceeds 10 ng/μl.

8.5.9 Compound Quantitation and Reported Detection Limits

Sample results reported by the laboratory will be compared with the raw data. Detection limits will be checked to ensure that adjustments are included that reflect all dilutions, concentrations, splits, cleanup activities, and dry weights.

8.5.10 Overall Data Assessment and Corrective Action

The overall validity of the data will be assessed by the laboratory conducting the analysis, and a note made regarding any QC data that is out of specification or questionable. A data assessment form will be completed summarizing all the data reviewed for the particular group of samples. Appropriate corrective action concerning the specific problem will be taken immediately, and the laboratory will be contacted as necessary for further explanation, verification, documentation, or other appropriate action. All contacts with the laboratory will be documented. Contact records will be submitted with the data assessment form for final review.

8.6 Radiological Analyses

Radiologic analyses will be reviewed to Level a using the following criteria according to EG&G ERP SOP-12.1.2, "Radiological Data Validation":

- Evaluation of data completeness,
- Verification of instrument calibration,
- Measurement of laboratory precision using duplicates,

- Measurement of laboratory accuracy using spikes,
- Examination of blanks for contamination,
- Assessment of adherence to method specifications and QC limits, and
- Evaluation of method performance in the sample matrix.

9.0 Internal Quality Control Checks

Internal QC checks for the ANL-W laboratory analysis are found in the ALQAP. EWM will send subcontracted laboratories special spiked samples and field duplicate samples for internal QC checks. QC checks will be made of both laboratory and field work. Blind and blank samples will be made up as determined by audits. Preparation of the samples and frequency of checks are to be specified in standard operating procedures. Internal QC checks for subcontract labs will be included and reviewed as part of their QAPjPs.

All analytical samples will be subject to QC measures in both the field and laboratory. The following minimum field QC requirements apply to all analyses. These requirements are adapted from Test Methods for Evaluating Solid Waste: Physical/ Chemical Methods (SW-846) (EPA 1986a), as modified by the proposed rule changes included in the Federal Register, Volume 54, No. 13 (EPA 1989b).

- Field duplicate and triplicate samples
  Depending on the availability of sufficient sample quantities, field duplicate and triplicate samples will be collected at the frequency defined in a Groundwater Monitoring Plan. If no frequency is specified then, at a minimum, for each sampling event 5 percent of the total collected samples will be duplicated or one duplicate will be collected for every 20 samples, whichever is greater. Duplicate/triplicate samples will be retrieved from the same sampling location using the same equipment and sampling technique, and will be placed into identically prepared and preserved containers. All field duplicates/triplicates will be analyzed independently as an indication of gross errors in sampling techniques.

- Blind samples
  At the program manager's (PM's) direction, blind samples may be introduced into any sampling round for performance audit purposes. Blind sample type will be as directed by an analytical chemist; frequency will meet the minimum schedule requirements in the Groundwater Monitoring Plan. If no frequency is specified then, at a minimum, one blind sample will be collected for each major analysis (i.e., metals, volatiles, etc.) per year. Blind samples will be represented as field duplicate or field triplicate samples to the laboratory.

- Verification samples
  At the PM's direction, verification samples for performance audit purposes may be prepared for volatile aromatic, semivolatile base/neutral, and metallic analytes. Verification samples will be prepared by adding an aliquot of an EPA reference compound to the reagent water, and will be represented as field duplicate or field triplicate samples to the laboratory.

- Field blanks
  Field blanks will consist of pure deionized distilled water, transferred into a sample container at the site, and preserved with the reagent specified for the analytes of interest. Field blanks are used as a check on reagent and environmental contamination, and will be collected at the same frequency as field duplicate samples.

- Equipment blanks
  Equipment blanks will consist of pure deionized distilled water washed through decontaminated sampling equipment and placed in containers identical to those used for actual field samples. Equipment blanks are used to verify the adequacy of sampling equipment decontamination procedures, and will be collected at the same frequency as field duplicate samples.

- Trip blanks
  Trip blanks consist of pure deionized distilled water added to one clean sample container and will accompany each batch of containers shipped for the sampling activity. Trip blanks will be returned unopened to the laboratory, and are prepared as a check on possible contamination originating from container preparation methods, shipment, handling, storage, or site conditions.

The internal QC checks done by analytical laboratories will meet the following minimum requirements:

- Matrix spiked and matrix spiked duplicate samples
  Matrix spiked and matrix spiked duplicate samples require the addition of a known quantity of a representative analyte of interest to the sample as a measure of recovery percentage. The spike will be made in a replicate of a field sample. Replicate samples are separate aliquots removed from the same sample container in the laboratory. Spike compound selection, quantities, and concentrations will be described in the laboratory analytical procedures. One sample will be spiked per analytical batch or once every 20 samples, whichever is greater.

- Quality Control reference samples
  A QC reference sample will be prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range. Reference samples are required as an independent check on analytical technique and methodology, and will be run with every analytical batch or every 20 samples, whichever is greater.

Other requirements specific to a laboratories analytical equipment calibrations are addressed in Section 6. The INEL SMO has specific quality control requirements in their master task agreements with each individual laboratory. These control requirements are virtually identical to those stated, and will be used if sample analysis is contracted through the INEL SMO.

10.0 Performance and System Audits

Scheduled and unscheduled audits will be done to determine the accuracy and adherence to procedures. Audits will be conducted according to procedure AWP 5.4, "Performance Assessment." Audit findings will be corrected and documented in a final audit report. Administrative procedure AWP-4.7 addresses control of nonconformances.

As noted in Section 5.12 and Appendix A of Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, (QAMS-005) (EPA, 1983), audits in environmental investigations are considered systematic checks that verify the quality of operation of one or more elements of the total measurement system. In the sense intended by QAMS-005, audits may be of two types: (1) performance audits, in which quantitative data are independently obtained for comparison with data routinely obtained by the measurement system; or (2) system audits, involving a qualitative on-site evaluation of laboratories (or other organizational elements of the measurement system) for compliance with established QA program and procedure requirements. For this investigation, performance audit requirements will be met by the analysis of a minimum of one blind or one spiked sample for each analytical method identified in Table 7-1. Blind or spiked samples will not be identified as such to the laboratory and will be represented as a field or equipment blank. They may be made from traceable standards or from routine samples spiked with a known concentration of a known compound. At a minimum, at least one system audit will be performed; so that any required corrective action may be carried out in time to have a beneficial effect on project quality, the audit will be done shortly after the initiation of project activity.

Additional performance and system audits may be scheduled because of corrective action requirements (see Section 12 below), or may be done upon request by the QAR the technical lead, the ANL-W project manager, the DOE, or the EPA. Any discrepancies observed during the evaluation of performance audit results or during system audit surveillance activities, which cannot be immediately corrected to the satisfaction of the investigator, will be documented in a final audit report and resolved according to the ANL-W Quality Assurance Program. In addition, all aspects of analytical support activities done under the requirements of this QAPjP may also be evaluated as part of program-wide QA audits under the requirements of ANL-W Quality Assurance Program. Program audits will be conducted by qualified auditors.

Both management and independent assessments of groundwater monitoring activities will be conducted according to section C of the ANL-W Quality Assurance Program. These assessments will consist of both scheduled and unscheduled reviews of the procedures, field operations, and validation and reporting techniques.

11.0 Preventive Maintenance

Preventive maintenance is a means to eliminate unnecessary equipment failures and to ensure proper equipment performance. All measurement and testing equipment used in the field and laboratory that directly affect the quality of the analytical data will be subject to preventive maintenance measures that ensure minimization of measurement system downtime. Laboratories will be responsible for performing or managing the maintenance and calibration of their analytical equipment; maintenance requirements, spare parts list, and instructions will be included in individual methods and/or approved laboratory QAPjPs. It is the responsibility of EWM to see that preventive maintenance programs are established for equipment used in groundwater monitoring according to ANL-W procedure AWP 2.5.

12.0 Specific Routine Procedures Used to Assess Data Precision, Accuracy, Representativeness, and Completeness (PARC)

Precision and accuracy are two of the most important indicators of data quality. Completeness is an important indicator of laboratory performance. Precision is a measure of the variability associated with a measurement system. Accuracy measures the degree to which a measured value agrees with the "true" value for a given parameter; accuracy includes elements of both bias and precision. Representativeness is a measure of a laboratories ability to Completeness is a measure of the amount of valid data obtained compared to the amount expected to be obtained, under optimum conditions. The following equations will be used to assess the general precision, accuracy, and completeness of the measurement data provided.

12.1 Precision

The precision of analytical data can be evaluated using 1) standard deviation, 2) range, 3) coefficient of variation, also known as the relative standard deviation (RSD), and 4) percent difference.

12.1.1 Standard Deviation

The standard deviation is a measure of the average distance of individual observations from the mean. Standard deviation (s) will be defined as:

$$s = \sqrt{\sum_{i=1}^{n} \frac{(X_i - \overline{X})^2}{n-1}}$$

where s = the standard deviation;
n = sample size;
X_i = the value of the ith observation in the sample; and
$\overline{X}$ = the sample mean

12.1.2 Range

The range is simply calculated by subtracting the largest observation in a data set from the smallest observation in the data set. This is often referred to as R.

12.1.3 Coefficient of Variance

The coefficient of variance (CV), or relative standard deviation (RSD), is a commonly used measure of variability adjusted for the size of the values in the sample. It will be calculated as follows:

$$RSD = \frac{s}{\bar{X}} * 100$$

where s = the standard deviation; and
$\bar{X}$ = the sample mean

The coefficient of variation is used most often when the size of the standard deviation changes with the size of the mean. When individual measurements of CV can be combined (pooled) to obtain an overall measure of variability for a given type of analysis for measurement, the following technique is used:

$$Pooled\ CV = \frac{\sum_{i=1}^{n} X_{1_i}{}^{2} DF_1}{\sum_{i=1}^{n} DF_1}$$

where n = total number of data sets (e.g., total number of duplicate pairs);
X_1 = the CV of data set i (e.g., for one duplicate pair, i);
DF_1 = degrees of freedom from data set i (k_i - 1);
k_1 = number of data points in set i (e.g., k = 2 for duplicates); and
I = data set number (1, 2, 3, . . . n)

12.1.4 Relative Percent Difference

Relative Percent Difference (RPD) is another commonly used measure of variability that is adjusted for the size of the measured values. It is used only when the sample contains two observations and is given by:

$$RPD = \frac{(X_1 - X_2)}{0.5 * (X_1 + X_2)} * 100$$

where X_1 and X_2 are duplicate sample measurements' results. RPD is directly related to CV for duplicate results by:

$$RPD = 2\ CV$$

12.2 Accuracy

The accuracy of analytical laboratory data can usually be presented in terms of 1) relative error and 2) confidence intervals at a given percentage level (i.e., the 95% confidence interval).

12.2.1 Percent Relative Error

Percent relative error (PRE) will be defined as:

$$PRE = \frac{Measured\ Value - Actual\ Value}{Actual\ Value} * 100$$

12.2.2 Confidence Intervals

The 95% confidence interval is evaluated as follows:

$$95\%\ Confidence Level = \overline{X} \pm t_{(a,\ \sum^{n-1})} \frac{s}{n}$$

where $\overline{X}$ = the sample mean;
s = standard deviation;
n = sample size;
a = risk level (0.025 for the 95% confidence interval); and
$t_{(a,\ n-1)}$ = value of the tabulated students "t" distribution for n-1 degrees of freedom and risk level a.

Accuracy may also be expressed as percent recovery of a standard reference material (SRM). The percent recovered from such a method will be determined by the following equation:

$$\%\ Recovery = \frac{C_m}{C_a} * 100$$

where C_m = analytically measured concentration; and
C_a = actual concentration of the SRM used.

If a matrix spike sample is used instead of an SRM sample then the following equation will be used to determine percent recovered:

$$\% Recovery = \frac{S - U}{C_{sa}} * 100$$

where S = analytically measured concentration of spiked sample;
U = analytically measured concentration of unspiked sample;
C_{sa} = actual concentration of spike added

12.3 Completeness

Completeness will be calculated as follows:

$$\% Complete = \frac{V}{n} * 100$$

where V = number of valid measurements; and
n = total number of measurements necessary to achieve a specified level of confidence in decision making.

13.0 Corrective Action

EWM is responsible for ensuring corrective actions are taken when an activity associated with groundwater monitoring is found in noncompliance. Activities include procedure compliance, data reduction, internal QC checks, and other related elements of this project. All actions not in compliance will be identified and controlled or corrected. Control of nonconformances is addressed in AWP-4.6, "Deficiency Reporting System." Corrective action may be initiated from other activities that suggest a potential problem area may exist. Corrective action requests, required because of surveillance reports and nonconformance reports, will be documented and dispositioned as required by AWP-4.6. Corrective actions related to audit findings or observations will be documented and dispositioned in a formal audit report. Reports to management will be submitted for all corrective action and training recommendations. Primary responsibilities for corrective action resolution are assigned to the groundwater monitoring program manager. Other systems, procedures, or plan corrections that may be required because of routine review processes will be resolved as required by governing procedures or will be referred to the project manager for resolution. Copies of all surveillance, nonconformance, audit, and corrective action documentation will be routed to the QAR and the EWM central file upon completion or closure.

14.0 Quality Assurance Reports to Management

As previously stated in Sections 9 and 10, project activities will be regularly assessed by auditing and surveillance processes. Surveillance, nonconformance, audit, and corrective action documentation will be routed to the project quality records upon completion or closure of the activity. A report summarizing all audit, surveillance, and variation request activities, as well as any associated corrective actions, will be prepared at the completion of the current round of sampling by groundwater monitoring program personnel. The final report will include an assessment of the overall adequacy of the total measurement system with regard to the data quality objectives of the investigation.

EWM management will receive reports of performance audits, system audits, significant QA or QC problems, and recommended solutions. EWM management will also be informed of laboratory and interfield comparisons if significant discrepancies exist. EWM is responsible for informing RPS management of the status of groundwater monitoring. Management will be notified of any problems or anticipated problems with groundwater monitoring operations.

15.0 Quality Assurance Records

All project QA records will be retained to meet the requirements as described in Section 15.1. Primary record files will be located in the ANL-W GMP office. Primary record files will be periodically transferred to the EWM central files. All records will be considered permanent, and may be presented to National Archives and Records Administration (NARA) for permanent preservation after 25 years. The types of records that may be produced under the auspices of this plan will depend in large part upon the technical scopes of work for the individual tasks that the ANL-W GMP is requested to support, and the individual technical and QA procedures invoked to support those tasks. Quality Records that may be produced under the auspices of this plan are:

- this QAPjP and all revisions thereto;
- site- or task-specific technical work plans, SAPs, or QAPjPs, other project-level plans, implementing QA and technical procedures, and all revisions thereto;
- any INEL Sample Management Office Task Order Statement of Work (TOS);
- ANL-W or contractor drawings and technical specifications, where separate from project plans or procurement documentation, and all revisions thereto;
- Variation Request forms and all revisions thereto;
- training and qualification records;
- procurement records, including agreements for services, subcontracts, technical specifications, supplemental requirements, and all revisions thereto;
- health and safety plans and all revisions thereto;
- safe work permits;
- field log books;
- daily activity reports;
- chain of custody records;

- geologic logs;
- well completion diagrams;
- water level measurement data;
- test procedures and results;
- validated analytical data packages;
- validation reports;
- ANL-W and/or contractor task reports, with associated technical review records;
- nonconformance and unusual occurrence reports;
- corrective action and trend analysis reports;
- quality audit records; and
- quality-related task correspondence and telecon records.

15.1 General Requirements

QA records will be retained and managed for all ANL-W GMP activities as outlined in AWP 4.4, "Document Management." AWP 4.4 incorporates the minimum applicable requirements of DOE Order 1324.2A, Records Disposition (DOE, 1988). File organizations for individual service projects will be subject of the review and approval of GMP personnel and the QAR. Records indexes will be actively updated; corrections and additions may be made by hand, but will be formally updated at least quarterly. Updated copies of active records indexes will be routed to the QAR whenever they are formally updated. All records will be typed, or drawn or written in black ink except as noted in 15.2 below. Corrections will be made by drawing single lines through the revised text section requiring the change, and legibly writing or marking the necessary correction. All corrections will be initialed by the responsible person and dated; use of correction tape or white-out is prohibited.

15.2 Working Files

Working documents may be retained at field offices or subcontractor facilities within the allowances of IRTS-QP17.1. Working files may contain any documents deemed necessary to support completion of a task properly. At a minimum, they must contain copies of all work-initiating variation request, referenced specifications, all applicable procurement or contractual documentation, and any other documentation specifically invoked by a variation request. Standard metal filing cabinets or portable weather-resistant file boxes will be used for temporary storage of working documents. A complete set of applicable controlled documents (e.g., plans, procedures, and variation request forms) necessary to control specific field tasks will be maintained at individual sites or field offices as appropriate for individual projects. The chronology of all field activities will be documented in bound field logs according to INEL EIP-18, "Field Log Books."

15.3 Special Considerations for Analytical Laboratory Data and Monitoring Well Installation, Modification, or Abandonment Records

Copies of all analytical laboratory data that have completed all of the validation and reporting protocols described in Section 8 of this QAPjP, as well as all records of monitoring well installation, modification, or abandonment required by EG&G ERP SOP-11.6, "Standard Operating Procedure for Drilling of Monitoring Wells" and INEL EIP-2, "Abandoning/Decommissioning Groundwater Wells and Boreholes," will be routed to the ANL-W GMP QA records and applicable project records. Electronic copies of all validated analytical data will be routed for entry into the INEL Environmental Restoration Information System (ERIS) database; if unvalidated data is requested to be entered into ERIS, it will be flagged to show its unvalidated status.

15.4 Final Disposition of Project QA Records

Final disposition of ANL-W GMP project QA records will be defined by the GMP Manager. When final NARA guidelines are promulgated, records' disposition procedures will be updated to ensure that NARA schedule and terminology considerations are properly incorporated.

16.0 REFERENCES

1. ANL-W, Argonne National Laboratory - West Environment Safety and Health Manual, Argonne National Laboratory West, current issue.

2. ANL-W, Quality Assurance Program, W0001-0929-QM-04.

3. ANL-W, Environment, Safety, and Waste Management Procedures Manual, current issue.

4. ANL-W, Analytical Laboratory Quality Assurance Plan, W0660-0012-QP, current revision (Rev. 3).

5. ANL-W, AWP 2.5, Measuring and Test Equipment, current revision.

6. ANL-W AWP 3.1, Occurrence Reporting and Processing, current revision.

7. ANL-W, AWP 4.2, Quality Assurance Grading.

8. ANL-W, AWP 4.3, Document Management System, current revision.

9. ANL-W, AWP 4.4, Document Control, current revision.

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12. ANL-W, AWP 5.4, Performance Assessment, current revision.

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APPENDIX A

GLOSSARY OF TERMS

Audit or Assessment is a planned and documented activity performed according to procedures to determine, by examination and evaluation of objective evidence, the adequacy of and extent to which applicable elements of the program have been developed, documented, and effectively implemented following specified requirements. Audits or assessments can be either examinations of internal structures or external examinations of programs or activities of another organization.

Calibration is the adjustment of the system and the determination of system accuracy using known sources and instrument measurements. In certain applications, adjustment of flow, temperature, humidity or pressure gauges, and the determination of system accuracy, must be conducted using standard operating procedures and Standard Reference Materials (SRM) that are traceable to the National Institute of Standards and Technology (NIST) or other Certified Reference Materials (CRM) as approved by governing Quality Assurance Project Plans (QAPjPs).

Check is a verification as to correctness of a method. (Note: a check is less detailed than an audit).

Computer Program is a term referring to a sequence of instructions suitable for processing by a computer. Processing may include the use of an assembler, a compiler, an interpreter, or a translator to prepare the program for execution and to execute it. The term is considered synonymous with software.

Condition Adverse to Quality is an all-inclusive term used concerning any of the following: failures, malfunctions, deficiencies, defective items, and nonconformances. A significant condition adverse to quality is one that, if uncorrected, could affect safety or operability.

Corrective Action refers to measures taken to rectify conditions adverse to quality and, where necessary, to preclude repetition.

Data Quality is all the features and characteristics of data that bears on its ability to satisfy a given purpose. The characteristics of major importance are accuracy, precision, completeness, representativeness, and comparability. These characteristics are defined as follows:

- Accuracy - the degree of agreement of a measurement (or an average of measurements of the same thing), X, with an accepted reference or true value, T, usually expressed as the difference between the two values, X-T, or the difference as a percentage of the reference or true value, 100 (X-T)/T, and sometimes expressed as a ratio, X/T. Accuracy is a measure of the bias in a system.

- Precision - a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed in terms of the standard deviation. Various measures of precision exist depending upon the "prescribed similar conditions."

- Representativeness - expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

- Comparability - expresses the confidence with which one data set can be compared with another.

Data Validation is a systematic review of a data set to identify outliers or suspect values. More specifically, data validation refers to the systematic process of independently reviewing a body of analytical data against established criteria to provide assurance that the data are acceptable for their intended use. Validation methods include review of intra laboratory overchecks and laboratory quality assurance and quality control protocols; calculation overchecks; review of chain of custody documentation; review of the analytical requirements specified in the applicable field sampling plan, sampling and analysis plan, Quality Assurance Project Plan, or other appropriate project plan; review (and as necessary, revision) of data qualifiers; and other activities. The process may use appropriate statistical techniques to screen out impossible or highly unlikely values, if specified in applicable Quality Assurance Project Plans.

Deviation is a departure from specified requirements.

Document any written or pictorial information describing, defining, specifying, reporting, or certifying activities, requirements, procedures, or results. A document is not considered a Quality Assurance Record until it satisfies the definition included in this Glossary.

Environmental Monitoring is the collection and analysis of samples or direct measurements of environmental media.

Environmentally Related Measurements is a term used to describe essentially all field and laboratory investigations that generate data involving (1) the measurement of chemical, physical, or biological parameters in the environment, (2) the determination of the presence or absence of criteria or priority pollutants in waste streams, (3) assessment of health and ecological effect studies, (4) conduct of clinical and epidemiological investigations, (5) performance of engineering and process evaluations, (6) study of laboratory simulation of environmental events, and (7) study or measurement of pollutant transport and fate, including diffusion models.

Environmental Surveillance is the collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media from DOE sites and their environs and the measurement of external radiation for purposes of showing compliance with applicable standards, or assessing radiation exposures to members of the public, and/or assessing effects, if any, on the local environment.

External Audit refers to an audit of those portions of another organization's quality assurance program not under the direct control or within the organizational structure of the auditing organization.

Internal Audit refers to an audit of those portions of an organization's quality assurance program retained under its direct control and within its organizational structure.

Measurement is the quantification of a parameter, a contaminant, or gross content of material associated with soils, particulates, or a liquid or airborne effluent stream.

Measuring and Test Equipment (M & TE) refers to devices or systems used to calibrate, measure, gage, test, or inspect to control or acquire data to verify conformance to specified requirements.

Monitor has two definitions: 1) To measure certain constituents or parameters in an effluent stream continuously or at a frequency that permits a representative estimate of the amount over a specified interval of time, or 2) the instrumentation or device used in monitoring.

Monitoring is the use of instruments, systems, or special techniques to measure soil characteristics or liquid, gaseous, and/or airborne effluents and contaminants.

Nonconformance refers to a deficiency in characteristic, documentation, or procedure that renders the quality of material, equipment, services, or activities unacceptable or indeterminate. When the deficiency is of a minor nature, does not effect a permanent or significant change in quality if it is not corrected, and can be brought into conformance with immediate corrective action, it will not be categorized as a nonconformance. However, if the nature of the condition is such that it cannot be immediately and satisfactorily brought into conformance, it will be documented according to approved procedures and brought to the attention of management for disposition and appropriate corrective action.

Objective Evidence is any documented statement of fact, other information, or record, either quantitative or qualitative, concerning the quality of an item or activity, based on observations, measurements, or tests that can be verified.

Onsite refers to the area within the boundaries of a facility or site that is or can be controlled with respect to use by the general public.

Outliers refer to an extreme value that statistically does not belong to the group of values with which it is associated.

Performance Audit is a quantitative check of an analytical procedure with a material or device with known properties or characteristics to verify the accuracy of a project measurement system. The audit is usually done by a person different from the routine operator/analyst, using standards and equipment different from the calibration equipment.

Procedure is a written document that details an operation, analysis, or action whose mechanisms are thoroughly prescribed and is commonly accepted as the method for doing certain routine or repetitive tasks.

Procurement Document refers to the purchase requisitions, purchase orders, drawings, contracts, specifications, or instructions used to define requirements for purchase.

Qualification (Personnel) refers to the characteristics or abilities gained through education, training, or experience, as measured against established requirements, such as standards or test, that qualify an individual to do a required function.

Quality Assurance (QA) refers to those planned and systematic actions necessary to provide adequate confidence that a facility, structure, system, or component will perform satisfactorily and safely in service. Quality assurance includes quality control (QC), which comprises all those actions necessary to control and verify the features and characteristics of a material, process, product, or service to specified requirements. In other words, if quality is the degree to which an item or process meets or exceeds the user's requirements, then QA constitutes those actions that provide the confidence that quality was in fact achieved.

Quality Assurance Plan is an orderly assemblage of management policies, objectives, principles, and general procedures by which an agency or laboratory outlines how it intends to produce data of known and accepted quality.

Quality Assurance Program is a program that establishes the applicable quality requirements, identifies the responsibilities of personnel, organizations, and organizational units and subunits performing quality-related tasks, and suggests procedures to be followed in accomplishing quality-related tasks.

Quality Assurance Project Plan (QAPjP) refers to an orderly assemblage of management policies, project objectives, methods, and procedures that defines how data of known quality will be produced for a particular project or investigation.

Quality Assurance Record refers to an authenticated, completed document that furnishes objective evidence of the quality of items and/or activities affecting quality.

Quality Control (QC) refers to those actions necessary to control and verify the features and characteristics of a material, process, product, service, or activity to specified requirements. The aim of quality control is to provide quality that is satisfactory, adequate, dependable, and economic.

Quality Procedure an approved procedure shown to meet the specified requirements or its intended purpose.

Readiness Review is a systematic, documented review of the readiness for a startup or continued extended use of a facility, process, or activity. Readiness reviews are typically conducted before proceeding beyond project milestones, before institution of a major phase of work activities, or before starting work after the resolution of a stop work situation.

Sample refers to an extracted portion or subset of an effluent stream or environmental media; as applied to statistical analyses, the term also describes a subset or group of objects selected from a larger set, called the "lot" or "population." To be valid it must be randomly obtained and typify a homogenous quantity of material.

Sampling is the extraction of a prescribed portion of an effluent stream or of an environmental medium for purposes of inspection and/or analysis.

Site refers to the overall DOE complex consisting of one or more facilities in a defined geographic area.

Software Validation is defined as a demonstration that the conceptual model embodied in a computer program is a correct representation of the physical process or system for which it is intended. It is recognized that when complex natural physical systems are modeled, the degree of "correctness" is a subjective evaluation. Validation techniques may include simulation of field and laboratory test results, an external peer review of the technical basis for the model, a comparison of the approach with that used for similar validated models, a demonstration that the constitutive equations used in the development of the model meaningfully represents the physical system being modeled or other appropriate techniques.

Special Process refers to a process, the results of which are highly dependent on the control of the process or the skill of the operators, or both, and in which the specified quality cannot be readily determined by inspection or test of the product.

Supplier refers to any individual or organization who furnishes items or services according to a procurement document. "Supplier" is an all-inclusive term used in place of any of the following: vendor, seller, contractor, subcontractor, fabricator, consultant, and their subtier levels.

Surveillance Inspection is the act of monitoring or observing to verify whether an item or activity conforms to specified requirements.

System Audit is a systematic on-site qualitative review of facilities, equipment, training, procedures, record keeping, validation, and reporting aspects of the total quality assurance system, to arrive at a measure of the capabilities and abilities of the system to maintain QA/QC control. System audits are done on a scheduled, periodic basis.

Technical Review is a documented critical review of work that is within that state of the art performed by one or more qualified individuals who are independent of those who did the work but collectively have technical expertise at least equivalent to those who did the original work. A technical review is an in-depth analysis and evaluation of documents, activities, material, or data that require technical verification or validation for applicability, correctness, technical adequacy, completeness, appropriateness of interpretation, and assurance that established requirements are satisfied.

Unusual Occurrence (DOE 232.1)regulated or planned performance at a DOE operation that has environmental protection and compliance significance.

Variation Request refers to any deviation from established field procedure requirements or the requirements of an established QAPjP in response to unique circumstances encountered during sampling activities caused by unusual or nonroutine conditions that do not affect the ability to achieve prescribed performance standards or quality requirements.

Verification is the act of reviewing, inspecting, testing, checking, auditing, or otherwise determining and documenting whether items, processes, services, or documents conform to specified requirements. Verification should not be construed to be synonymous with (data) validation, but may be considered synonymous with assessment, as defined above.